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PISTIL RECEPTIVITY OF 'KHADRAWI', 'ZAHIDI' AND 'DEGLET NOOR' DATE FLOWERS¹

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The traditional method of pollinating female date-palm inflorescences is to insert a number of male strands or a ball of cotton wool containing pollen into the inflorescence. Since this has to be performed soon after the spathe cracks, all the inflorescences on one tree cannot be pollinated at the same time. Even on low palms, much of the time required to carry out pollination is spent in actually getting to the inflorescence. As trees grow taller, the time required for this operation naturally increases.

To save labor, pollination with the aid of a duster has been introduced in most Israeli date gardens. A long aluminum pipe is used to convey the pollen to recently opened inflorescences, with the garden being pollinated at frequent intervals. The question arose: how frequently has pollen to be applied to a date garden as a whole to ensure maximal fruit set? Varieties with a long period of pistil receptivity may be pollinated at less frequent intervals than those with a short period of receptivity.

The period of pistil receptivity was studied in various countries; in the U.S.A. by Albert (1), Leding (2), and recently by Ream and Furr (6); in North Africa by Monciero (3, 4), Péreau-Leroy (5) and Wertheimer (10); and in Israel by Stolar and co-workers (8, 9). All these authors found a fall-off in receptivity with time which varied with the variety. There is, however, no agreement between authors as to when reduced receptivity lowers fruit set significantly. Deglet Noor flowers have been reported to show diminished receptivity after the following number of days from spathe crack: 12-16 (2), 10-12 (10), 8-9 (3, 4), 7 (6), and 8, 10 or 12 days in three different years (8). One of the explanations for these discrepancies may well be the time at which the various authors examined fruit set. This point, as will be explained, is most important, but the time of examination is not mentioned in most of the above reports.

At the early stages of fruit development, it is impossible to distinguish between fertilized fruit and parthenocarpic singles (7). It is therefore most likely that if the examination took place when the fruits were still very small, parthenocarpic singles were included in the category of fertilized fruit. An indication that results may vary at different dates of examination may be seen in data presented by Stolar et al. (8). Control Barhee strands were isolated and not pollinated. A month after spathe crack, examination revealed 51% fruit set, whereas at the second examination, approximately 3 months after spathe crack, only 8% of the fruit was seeded, the remainder being parthenocarpic.

Since only seeded fruits are of commercial value, it is important that percentage fruit set be determined at a time when a distinction can be made between fertilized and parthenocarpic fruits; it might be still better if this were done at an even later stage, close to ripening.

The question of how long pistil flowers

are receptive arose again when young trees started to bear in the new date growing region in the south of Israel. Because of lack of agreement in reports on the duration of receptivity in different varieties, it was decided to study the situation in the three main varieties grown in this region.

MATERIALS AND METHODS

The period of pistil receptivity was investigated in the Yotvata date garden (22 miles north of the Red Sea). Zahidi inflorescences were tested in 1964, and Khadrawi and Deglet Noor in 1965.

Closed spathes were chosen, washed in 80% alcohol, and slipped individually into double polyethylene sleeves. One end of the sleeve was tied to the base of the inflorescence after encircling the spathe above and below the point of tying with thick wads of cotton wool (which prevented uncontrolled entry of pollen). The other (top) end of the sleeve was also plugged with cotton wool to exclude pollen but admit air. The polyethylene sleeves were covered with brown paper bags to avoid over-heating of the inflorescences. The isolated inflorescences were examined daily. If the spathe was elongated, the exposed portion was washed in alcohol and covered with an additional layer of cotton wool. When spathe cracking was observed (by lifting the paper bag), the polyethylene sleeve was removed and the strands in the bunch were divided into 7 groups of 6 strands. All remaining strands were removed. Six of the 7 groups were immediately covered with polyethylene sleeves of appropriate size, plugged with cotton wool and covered with paper bags as described above for the whole bunch. The seventh group of strands was pollinated immediately with a large quantity of fresh pollen mixture as used in commercial gardens. This pollination and the day of spathe crack will be referred to henceforth as day zero. From day zero, every 2 days a different group of strands was opened and pollinated so that the sixth group was pollinated on the tenth day from spathe crack. After pollination, the strands were left uncovered. The seventh, control group, remained unpollinated and isolated and was uncovered 3 to 4 weeks after spathe crack.

Two inflorescences were treated as described on each of 5 Zahidi and Deglet Noor palms, and 6 Khadrawi palms (i.e., 10 or 12 bunches observed for each variety). Spathe crack in these inflorescences occurred between the following dates: Zahidi March 19-28, 1964; Khadrawi March 18-25, 1965; and Deglet Noor March 31-April 11, 1965.

The percent of fruit set was determined at 2 times: when the fruit was the size of a pea (Zahidi - 5/10/64, Khadrawi - 6/5/65, Deglet Noor - 6/9/65), and at khalal, when the fruit changed from green to its characteristic color. At khalal all the strands were removed from the bunch, the number of fruit scars and seeded fruits was recorded and the percent fruit set was calculated. Each group of strands in a bunch was considered as one unit for statistical analysis.

RESULTS

Results of fruit-set counts in the 3 varieties at 2 developmental stages of the fruit (pea size and khalal) are presented in Table 1. The reduction in percent of set starts at different times in the 3 varieties: in Khadrawi 2 days, in Zahidi 4 days and in Deglet Noor 8 days after spathe crack.

Within the pollination period during which the percent fruit set obtained does not differ statistically, there was a day on which maximal fruit set was obtained: in Khadrawi, on the day of spathe crack; in Zahidi, on the day after; and in Deglet Noor, on the fourth day after spathe crack.

An interesting fact, especially marked with Deglet Noor, is that the day of pollination which produces maximal fruit set varies in different inflorescences (Table 2). Although we have only few data, it seems the maximal fruit set depends mainly on factors within the tree. This is especially noticeable in tree no. 2, where pollination 4 days after spathe cracking produced maximal fruit set in inflorescences which flowered on different dates (April 2 and 11, respectively). A comparison of inflorescences opening on the same day (April 2) also shows that maximal fruit set was obtained from different pollination dates in the different inflorescences.

Table 1. Fruit set percentage of Zahidi, Khadrawi and Deglet Noor date palm trees following pollination at different times after spathe crack

Variety	Fruit 'stage' at examination	Pollination (days after spathe crack)						Control ¹
		0	2	4	6	8	10	
		% fruit set						
Zahidi	Pea size	69.9ab ²	80.9a	78.8a	61.6bc	52.4c	38.9d	11.4e
	Khalal	64.5a	76.7b	74.0ab	52.0c	46.5c	31.5d	8.1e
Khadrawi	Pea size	69.2a	59.5a	45.8b	43.5b	39.7b	27.3c	22.3c
	Khalal	60.0a	53.3a	42.4b	35.7c	25.4d	19.8de	13.7e
Deglet	Pea size	63.8a	66.4a	68.7a	64.7a	61.6a	55.0b	25.3c
Noor	Khalal	55.4a	55.5a	59.8a	56.9a	53.5a	44.0b	16.2c

¹ Unpollinated isolated strands; isolation discontinued one month after spathe crack.

² Means in the same line followed by different letters are statistically different at the 5% level.

¹ Contribution from The Volcani Institute of Agricultural Research, Bet Dagan, Israel. 1970 Series, No. 1748-E.

DISCUSSION

The results presented above agree in part with those of Stolar et al. (8, 9), who investigated pistil receptivity in another date-growing region in Israel (Jordan and Bet She'an valleys) during a number of years. Our results with Khadrawi are very similar to those obtained by them in 2 different years. For Zahidi, Stolar et al. found that a reduction in pistil receptivity occurred after the 3rd day in one year, after the 6th day in another, and in two gardens after the 4th day in a third year (8). Our results showed that pistil receptivity falls off after the 4th day. For Deglet Noor, pistil receptivity fell off after the 8th day, which is very close to Ream and Furr's findings (6) and corresponds to the shortest period recorded by Stolar et al. (8) in 3 years of investigations. The discrepancies between our results and those of Stolar et al. are probably due to examination of fruit set at different time intervals from spathe crack in the different years; in most cases their date of examination was too early for definite determination of percent fruit set.

The supposition that maximal fruit set occurs at different times on different bunches has lately been partly strengthened by Ream and Furr (6), who found a very high variability in the percentage of fruit setting on different bunches which cracked on the same day and were pollinated at the same time after cracking. When determining the suitable time interval between pollinations, one has to decide whether to take into account the period up to maximal pistil receptivity or the day when receptivity falls off. The author feels that the decision depends on the method of pollination used. When male strands are inserted into the spathe, one may assume that pollen will be released for longer than one day. In this case the surrounding air will contain sufficient quantities of pollen to pollinate neighboring inflorescences which open later, and repollination may also occur in the inflorescence containing the male strands. It seems, therefore, that when using male strands the interval between pollinations can be directed by the time between spathe cracking and fall-off in pistil receptivity. When a dusting machine is used, the quantity of pollen falling on each inflorescence is smaller than in the former case, and the pollen is more likely to be damaged, because of its dispersal in the atmosphere. One can therefore assume that vitality of the pollen is confined to the day of pollination. If this is true, the interval between pollinations must be in accordance with the time interval between spathe cracking and maximal fruit set, thus ensuring that inflorescences are pollinated just before or at the time of maximal receptivity. If maximal pistil receptivity occurs at different times on different trees of the same variety, as seems to be the case according to Table 2, our claim for using the onset of maximal receptivity and not its decline as the deciding factor is strengthened.

ABSTRACT

Strands on the same inflorescences of Khadrawi, Zahidi and Deglet Noor date palm trees were pollinated at various time intervals up to 10 days after spathe cracking. A significant decrease in fruit set was found when pollination was performed: in Khadrawi 2 days, in Zahidi 4 days and in Deglet Noor 8 days after spathe cracking. Absolute maximal fruit set was obtained with pollination at shorter periods after spathe cracking in all 3 varieties. The day of pollination which produced maximal fruit set varied in different inflorescences of the same variety. For Deglet Noor, the time

Table 2. Fruit set percentage obtained from pollination at different times after spathe crack, in different inflorescences of Deglet Noor date palm trees. (Examination at Khalal)

Tree no.	Inflorescence no.	Date of spathe crack (1965)	Pollination (days from spathe crack)					
			0	2	4	6	8	10
			----- % fruit set -----					
1	1	April 2	62	56	53	35	50	48
	2	April 2	62	64	53	35	50	48
2	1	April 2	38	54	59	48	39	25
	2	April 11	38	47	63	60	38	15
3	1	April 8	63	66	69	65	60	59
	2	April 1	62	51	59	68	56	55
4	1	March 31	68	66	60	70	66	63
	2	April 2	60	71	69	73	63	52
5	1	April 2	48	42	54	51	48	31
	2	April 11	53	38	51	45	59	40

when maximal fruit set was achieved seemed to be dependent mainly on factors within the tree.

The time interval between pollinations is discussed from a practical point of view. When using whole male strands for pollination, it is suggested to employ intervals which will not result in a significant reduction in fruit set; shorter intervals, which will ensure maximal fruit set, are suggested for the duster method of pollination.

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BIOLOGY AND CONTROL OF MAUGINIELLA SCAETTAE CAV., THE PATHOGEN OF KHAMEDJ DISEASE IN THE UNITED ARAB REPUBLIC

IBRAHIM FAHMY MICHAEL and KAMAL ALI SABET¹

Khamedj, or inflorescence rot, of date palms was described more than 40 years ago in Libya and is a major disease. The causal fungus, *Mauginiella scaettiae* Cav., is sometimes responsible for serious damage to the date crop in several African and Middle Eastern countries. Previous work on khamedj has been summarized by Michael and Sabet (5) and by Elmer et al. (3).

In 1966 the disease was identified for the first time in the Sinai Peninsula of the U.A.R. (5). It was widespread in the coastal areas of northern Sinai and caused serious damage to the date crop, with losses up to 40% in some localities. The disease was rather uncommon in inland areas of Sinai and it was not observed in southern Sinai.

THE DISEASE

Initial stages of infection by the fungus are not easily discernible on the inflorescences. The first external signs of the disease are characteristic, elongated, reddish spots which appear on the surface of the spathe in the spring; these lesions, however, indicate that the underlying flower buds may have already been attacked. The affected tissues turn brown, and the resulting lesion finally spreads over the greater part of the spathe. Cutting the spathe lengthwise releases an unpleasant odor. The main axis of the inflorescence and its branches are partly to entirely coated with a white to pinkish growth of the fungus. In mild infections, only part of the floral buds are destroyed and fall, while those remaining at the base of the inflorescence develop normally. Brown, oval to elongated lesions may appear on such mildly infected inflorescences. In severe cases, the entire inflorescence is destroyed and no fruit is produced (Fig. 1).

Three potential sources of inoculum are: 1) infected inflorescences remaining in palms from the previous season where the fungus persists, especially in the thick tissues of the rachis; 2) infected leaf bases, which appear to be of particular importance since they ensheath the developing spathes during their most susceptible stage; and 3) contaminated pollination spears, a pollinating device unique to Sinai, which may carry the fungus from infected to healthy spathes during pollination.

M. scaettiae was isolated from roundish brown lesions with raised edges (Fig. 2) on leaf bases in May, June and September, suggesting that such lesions may harbor the pathogen throughout the year. In many localities unattended male palms used only as a source of pollen are important sources of inoculum.

PHYSIOLOGICAL STUDIES

Spore germination: To obtain information on the effect of temperature on germina-

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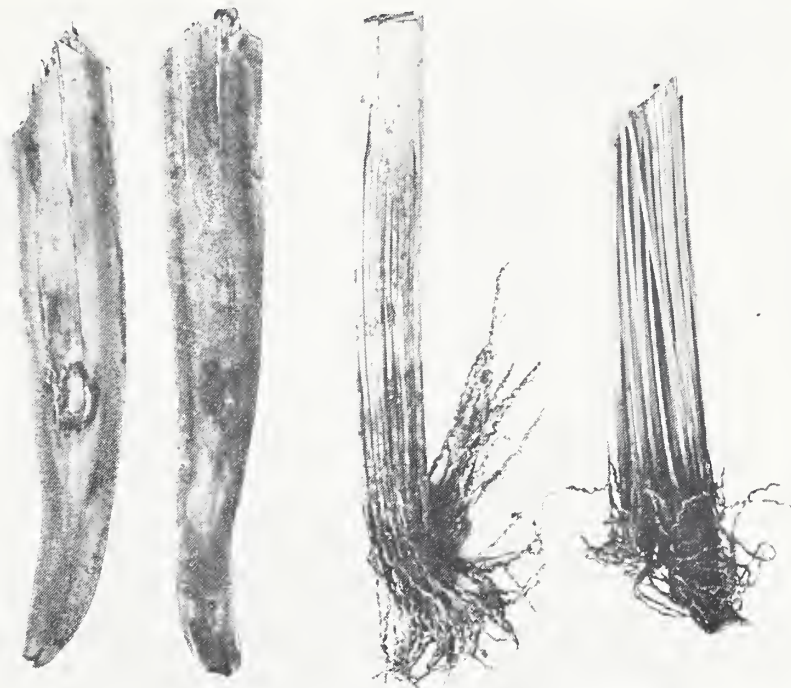


Fig. 1. Inflorescences (left) and closed spathes (right) of date palm showing infection with khamedj disease.

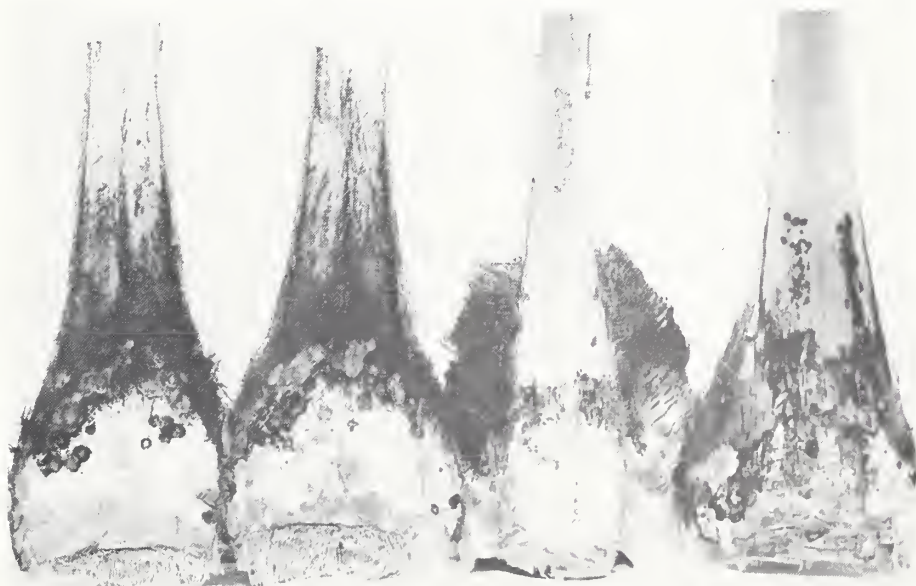


Fig. 2. Lesions of *Mauginiella scaettiae* on the inner side (2 on left) of leaf bases and on the outer side (2 on right).

tion, conidia of *M. scaettiae* were taken from 2-week-old potato dextrose agar (PDA) cultures, suspended in sterile water, and placed on flamed glass slides. The slides were kept in moist chambers incubated at temperatures from 7 to 37° C. Percentage of germination and length of germ tube were determined by examining 10 microscope fields (containing 250-300 conidia each) for each temperature treatment. The results

Table 1. Effect of temperature on spore germination of *Mauginiella scaettiae* conidia

Temperature °C	Germination after 24 hr	
	%	Length of germ tube (microns)
7	—	—
15	8.9	13.8
17.5	28.0	29.1
21	47.2	40.6
25	44.4	26.3
30	22.1	19.7
37	—	—

(Table 1) show that maximum germination and germ tube elongation occurred at 21° C., with the minimum between 7 and 15° C. Germination and growth were depressed and virtually ceased between 30 and 37° C. Length of germ tube coincided with the percentage of germination with respect to effect of temperature.

The effect of temperature on growth was determined by seeding 90 mm Petri dishes containing PDA with a 4 mm culture disc taken from the periphery of a 2-week-old culture of the fungus. Four plates were incubated at each of 4 temperatures. The diameter of the colonies was measured every 5 days along 2 perpendicular axes. The results (Table 2) conform to those for spore germination and show an optimum temperature of about 20° C. for growth of *M. scaettiae*.

Daily maximum air temperatures in Sinai during the early spring period of spathe development range between 16 and 24° C, which corresponds to the optimum range for growth and spore germination of the fungus. The fungus is sensitive to temperatures above 25° C. (Fig. 3).

pH requirements: To study the effect of pH on growth, we prepared 5 phosphate buffer solutions of pH values ranging from 4.7 to 8.0 as described by McLean and Cook (4). A sixth solution containing 1% potassium phosphate was also prepared and adjusted to pH 4.1 by the addition of N/10 hydrochloric acid. To the 6 solutions above, 5% sucrose, 1% potassium nitrate, 0.25% magnesium sulphate and a trace of ferric chloride were added. The media were distributed in 100 ml flasks in 20 ml quantities and autoclaved. The pH value in each set of flasks was checked. The flasks were seeded with culture discs of uniform diameter and incubated at a suitable temperature. The dry weight of the mycelium was determined after incubation for 15 and 30 days, respectively, using in each case 4 replicate flasks per treatment.

The results (Table 3) indicate that a near neutral or slightly alkaline reaction was more favorable for the growth of the fungus than an acid reaction. However, differences between the treatments were not great and showed that the fungus could grow well at pH values from 4.1 to 7.3. In older cul-

Table 2. Effect of temperature on linear growth of *Mauginiella scaetta* on PDA

Incubation period	Avg diam of colonies grown at given temp, °C						
	10	15	20	25	30	35	40
Days	mm	mm	mm	mm	mm	mm	mm
5	7	21	30	25	13	—	—
10	10	40	49	37	13	—	—
15	10	59	76	57	15	—	—
20	11	74	90	59	43	—	—

Table 3. Effect of pH of liquid media on growth of *Mauginiella scaettiae* as indicated by dry weight of mycelium after 15 or 30 days growth

Initial pH	After 7 days pH	After 15 days		After 30 days	
		pH	Dry weight	pH	Dry weight
4.1	4.4	4.3	190.9±14.12	4.2	163.1± 6.2
4.7	4.8	4.6	216.5± 7.6	4.5	166.5± 4.1
5.4	5.7	5.4	226.1± 7.5	5.2	201.0± 8.8
6.3	6.6	6.3	218.7±15.0	6.1	203.5± 9.3
7.0	7.3	6.9	233.3±10.1	6.7	195.0± 5.3
7.3	7.5	7.1	237.6±11.4	7.0	190.1±16.3

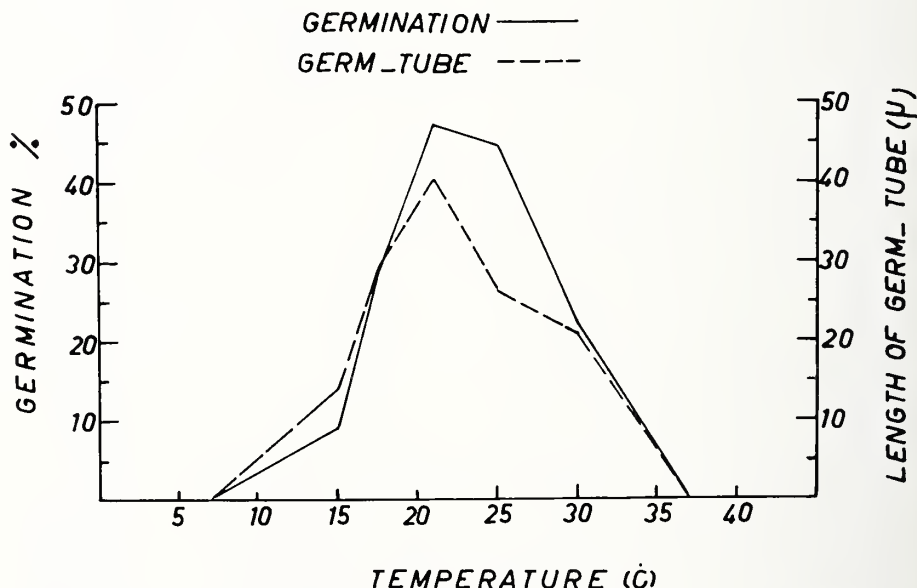


Fig. 3. Effect of temperature on spore germination and length of germ-tube.

tures the loss of weight was least at pH 6.3.

Carbon and nitrogen assimilation: Assimilation of various carbon and nitrogen sources was determined by adding the required nutrients aseptically to a basic, autoclaved Richard's solution from which either C or N compounds had been deleted, as required. Carbon and N compounds were added aseptically at the following levels: C = 1% sucrose or 4.21 g C/liter; N = 1% KNO₃ or 1.39 g N/liter. A final volume of 20 ml of nutrient solution was distributed in 100 ml Erlenmeyer flasks, 5 for each test and incubation period. The flasks were autoclaved momentarily at 15 psi and incubated for several days to confirm sterility. Each flask was seeded with a 6 mm culture disc of the fungus and incubated at 20° C.

Mycelial mats from each set of replicates at 15 and 30 days, respectively, were dried to constant weight at 60° C.

Sucrose was the most suitable C source for the growth of the fungus, but other carbohydrates supported growth also (Table 4). Growth was considerably enhanced at high levels of a suitable C source and a maximum growth point was not reached at 10% glucose.

Peptone was the most suitable N source for growth (Table 5). The response of the fungus to increased levels of inorganic N (KNO₃) was definitely less than its response to increased levels of a C source.

Toxicity of fungicides to spores: The

Table 4. Effect of different carbon sources on growth of *Mauginiella scaetiae* in a basic Richard's solution

Carbon sources	Dry weight of mycelium	
	After 15 days	After 30 days
	mg	mg
Control	51.9±3.9	59.5±12.1
Glucose	78.8±2.9	87.6± 2.1
Fructose	82.3±2.5	83.9± 4.9
Sucrose	87.0±3.8	82.5±10.5
Maltose	76.1±4.9	78.4± 4.4
Starch	85.4±3.3	78.8± 1.5

Table 5. Effect of different nitrogen sources on growth of *Mauginiella scaetiae* in a basic Richard's solution

Nitrogen source	Dry weight of mycelium	
	After 15 days	After 30 days
	mg	mg
Control	90.6± 6.8	95.5± 6.6
Potassium nitrate	122.5±11.2	125.3±14.2
Ammonium sulphate	155.9±14.9	184.7± 3.7
Urea	164.3± 6.4	230.1± 5.6
Asparagine	263.0±13.7	250.7±12.7
Peptone	315.4±22.2	349.7±15.6

method used to examine the toxicity of fungicides to conidia of *M. scaetiae* was essentially similar to that recommended by the American Phytopathological Society (1).

The fungicides were prepared in distilled water and 0.02% Triton G² was added to improve dispersal. The required concentrations of each fungicide were reached when 1 ml of the fungicidal mixture was combined with 1 ml of a conidial suspension of the fungus. Drops of the resulting mixtures were placed on clean slides in quadruplicate. The slides were kept in moist chambers at 20° C for 24 hr. Germination percentages in the different treatments were based on an examination of 250–300 conidia after 24 hr of incubation.

Bordeaux mixture was prepared according to the recommendations of the American Phytopathological Society (2).

Fermate and Bordeaux mixture were the most toxic fungicides to the spores of *M. scaetiae* (Table 6). Duter (triphenyl-tin hydrochloride) and Cupravit (copper oxychloride) were almost equally toxic. Dithane Z 78 (zinc ethylenc-bis-dithiocarbamate) was the least effective fungicide.

DISEASE CONTROL

Fungicides: Fungicidal control of khamedj was accommodated to the simple agricultural operations of the Sinai date growers. Fungicides applied with hand dusters were ineffective in preliminary tests and were abandoned. Fungicidal sprays were applied to leaf bases and spathes or to the area in which spathes originate on female palms. All old inflorescences were removed after harvest.

In 1963-1964, preliminary tests were

made on Hayani palms in the Bir El-Abd district where khamedj caused severe damage. Knapsack sprayers operated by 2 men were used. The best schedule involved a post-harvest application in October 1963, an early spathe emergence application in January 1964 and a post-emergence application in March 1964. Cupravit and Duter had reduced the percentage of infected spathes by about 50% in May 1964. These materials were retained for later trials.

In 1964-1966, fungicides were applied with power-driven sprayers at 300 psi. Workers climbed the palms while holding the spray nozzles connected by pressure tubing to a sprayer on the ground. The terminal bud area and surrounding leaves, leaf bases and spathes were sprayed at the rate of about 10 liters per palm.

The 3 applications of each fungicide included a post-harvest spray in December, early-spathe-emergence spray in January and a post-emergence spray in March, except at Bir El-Abd in 1964-1965, where 4 sprays were applied from January to March.

Duter and Cupravit were the most effective among the 4 fungicides tested (Table 7). These results and unpublished data indicate that a post-harvest spray is essential for good control, followed by an application in January and March, respectively.

The 1966 results, obtained from trees sprayed with the same fungicide in 2 successive years, indicate that a cumulative effect on control with repeated spraying might be anticipated. This would be influenced by sanitary measures used in neighboring plantings, which suggests that the control of khamedj should be organized on a community basis for the most effective results.

Leaf pruning trials: The relation of pruning to control of the pathogen was examined. In 2 isolated localities in the Bir El-Abd district, trees were moderately pruned, leaving 10–15 leaves, and severely pruned, leaving 4–6 leaves, respectively. The leaf bases and fiber were removed with each leaf. The trees received 3 applications of fungicide.

Duter and Cupravit gave good control in comparison to disease development on unpruned and unsprayed palms. However, the pruning was too drastic and the subsequent crop was markedly reduced. Also, there were no adequate leaf rachises to which the current season's bunches could be tied and many bunches broke or were otherwise damaged.

SUMMARY

1. The khamedj disease mainly affects the

Table 6. Effect of fungicides on germination of conidia of *Mauginiella scaetiae*

Concentration	Germination				
	Fermate 76% W.P. ¹	Bordeaux mixture ²	Duter 20% W.P.	Cupravit 50% W.P.	Dithane Z 78 71% W.P.
p.p.m.	%	%	%	%	%
0 ³	42	32	42	42	42
25	—	1	—	—	—
50	—	0	—	—	—
62.5	0	—	2	2	23
125	0	—	0	0	9
250	0	—	0	0	3
500	0	—	0	0	0

¹ W.P. = Wettable powder

² Tests with Bordeaux mixture were performed as a separate experiment.

³ Distilled water, control

Table 7. Fungicidal control of khamedj disease on severely infected date palms in two successive seasons

Locality	Year	Spathes per treatment, avg	Infected spathes				
			Control	Duter	Cupravit	Bordeaux	Dithane
		No.	%	%	%	%	%
Bir El-Abd	1965 ¹	177	58	—	20	42	48
	1966	— ²	50	5	5	12	10
El Arish	1965	278	84	28	31	44	74
	1966	—	86	10	20	13	54
Sheik Zuwaid	1965	188	65	25	30	49	64
	1966	—	85	28	31	41	52

¹ 4 applications, all during the spathe emergence to post-emergence period, January-March.

² Up to twice as many spathes were used in the 1966 tests, but the data are unavailable.

²/ The use of trade names is for convenience only and does not imply endorsement of the product listed over that of similar products.

spathes during their development in spring. Elongated reddish spots appear on the surface of the spathe and the underlying flower buds rot and fall. In mild infections, only part of the floral buds are destroyed. The whole inflorescence may be destroyed in severe infections.

2. Three important sources of infection are: a) infected inflorescences remaining on the palms, b) infected leaf bases which ensheath the developing spathes, and c) contaminated pollination spears.
3. The optimum temperature for spore germination and growth of the causal fungus is about 20° C. The fungus is sensitive to high temperatures.
4. A medium with a nearly neutral reaction is most favorable for growth of the fungus. However, growth occurs at pH values ranging from 4.1 to 7.3.
5. The fungus can utilize many carbon compounds, especially sugars. It requires

a high level of a suitable carbon source for good growth. Peptone is the most suitable nitrogen source. The response of the fungus to increased levels of inorganic nitrogen (KNO₃) is meager and does not compare to its response to increased carbon levels.

6. The toxicity of 5 fungicides to the spores of the fungus was examined under laboratory conditions. Duter, Cupravit, Fermate and Bordeaux mixture are highly toxic. Dithane Z 78 is less toxic.
7. A program for controlling the khamedj disease is proposed. This includes (a) removal of infected spathes, (b) pruning of leaves including removal of the leaf base, (c) spraying of palms with a suitable fungicide such as Duter or Cupravit and (d) organization of control on a community basis. Three applications per year are recommended, the first in November–December, the second in January–February and the third in February–March. Drastic leaf pruning is not advisable.

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ECONOMIC IMPORTANCE AND CONTROL OF BATRACHEDRA AMYDRAULA MEYR. (THE LESSER DATE MOTH) IN THE U.A.R.

IBRAHIM FAHMY MICHAEL¹

The major date palm insects in Sinai Province were surveyed during the 1965–1966 fruit seasons. *Batrachedra amydraula* Mevr., the lesser date moth (Fig. 1), rec-

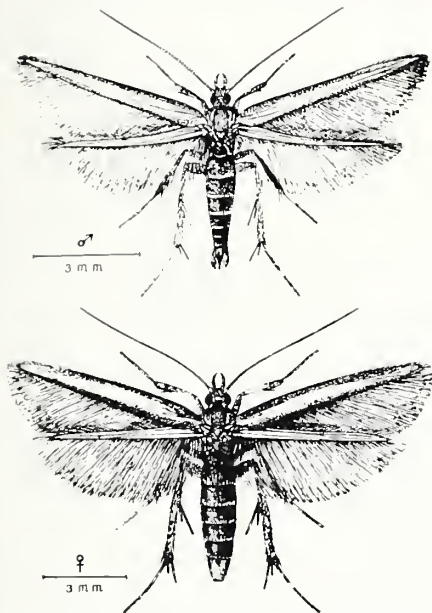


Fig. 1. Adults of *B. amydraula* Meyr.
Top, male; bottom, female.

orded for the first time in the U.A.R. was the only insect that caused serious damage to date fruits. Detailed studies on the biology, ecology and control of this insect were made, but only the latter studies are presented here. Buxton in 1918 (2) was the first to describe this insect from Iraq. It was recorded subsequently in Libya and Iran (4).

Various materials have been recommended for control of *B. amydraula*, but the most extensive recent work was done by Abd-El Hussain et al. (1). They reported that DDT, malathion or Diptrex at the rate of 500 g/100 gal water or Diazinon at the rate of 300 g/100 gal water was effective for the control of this insect. Sprays were applied at the rate of about one gal per tree. They recommended a first spray with DDT one week after pollination followed by a second application of Diazinon, malathion or Diptrex after 15–35 days.

DISTRIBUTION, DAMAGE AND SYMPTOMS

Infestation by *B. amydraula* in Sinai Province is confined to the northern sector especially in the Bir El-Abd area. This infestation may be attributed to the low temperature and high relative humidity prevailing in the north. The assessed damage to infested date palms was around 75% of the yield. This corresponds to the findings of Dutt (3), who stated that the damage caused by the "hashaf" condition (= lesser date moth infestation) in Iraq during 1918 was about 70% of the crop.



Fig. 2. Healthy, immature date fruits (left) and fruits infested with *B. amydraula* (right). Infested fruits are detached from the strand, but they are kept in place by a web spun by the larvae.



Fig. 3. Seeds of different ages from date fruits infested by *B. amydraula*.

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B. amydraula severely damages young immature dates. The characteristic symptom of infestation is the pale reddish color which is known locally as "Humairah" (1). Infestation of fruit starts in Sinai in the middle of May. To prevent the infested date fruit from dropping, the larva starts spinning a web around it and the strand. Then the minute larva attacks the fruit through an entry hole near the calyx. It bores towards the seed, which is tender at this stage. As infestation progresses the young fruit stops growing and separates from the stalk, but temporarily the web prevents it from dropping. About 4 weeks are required for full expression of symptoms, during which time the fruit becomes pale reddish and the skin dries. A comparison between infested and uninfested fruits of the same age is shown in Fig. 2.

In the early stages of infestation, the only external feature of larval attack is the visible entry hole near the calyx, and the frass and web around it. The larva will be found in the furrow of the seed, on which it feeds mostly rather than on the flesh of the fruit. Damage to seeds of infected fruits of different ages is shown in Fig. 3. When the larva attacks a later stage of the growing fruit during July and August, the web is not strong enough to hold the abscised fruit to the strand and infested fruits fall to the ground and deteriorate. In a severe infestation, almost all of the fruits fall to the ground. The bunches cease growing and become dry.

Larvae hatched in September do not complete their life cycle immediately, but hibernate in fiber at the base of the leaves and in dry fruitstalk tissues. Therefore, sanitation involving removal of old fruit stalks, fiber and fallen fruit complements chemical control by reducing the population of the lesser date moth in the first, and most important, spring hatch.

EXPERIMENTAL WORK

The experiments were designed to determine the time and number of insecticide applications required for economic control of *B. amydraula*. Spraying proved to be effective, though it was handicapped by a lack of fresh water in some localities. An experiment was carried out to learn whether saline well waters influenced the effectiveness of the insecticides. Combined spray programs for the control of *B. amydraula* and the khamedj disease were investigated. However, these trials were unsuccessful because timing of the two spray schedules did not coincide.

Methods and Materials. Insecticides were applied with a high-volume, motorized sprayer (300 psi). The palms were tall and trained operators climbed them by means of a girdle. The nozzle was lifted by means of a rope carried by the operator, who then applied the spray mixture directly to the bunches to insure complete coverage of the fruit. Six insecticides or mixtures of insecticides were used (Table 1). The fallen fruits from each tree were examined daily from the first application until fruit harvest. Fallen fruit were divided into natural and infested categories. Daily counts of each category were summed for each treatment and the percentage infestation for the sum of each 10 days was calculated. The total yield of each tree was weighed and the average yield per bunch calculated. Analysis of variance was made for the average yield in kg per bunch. The weight of 50 fruits from each tree was taken as an index of the size of fruits. Three of the insecticides were applied in well waters with up to 6400 ppm total solids.

Results. DDT-Lindane and Zolone were the most effective insecticides, followed by Lebaycid, Sevin and Nexion (Fig. 4). No statistically significant differences occurred

Table 1. Insecticides used for control of *B. amydraula*

Insecticide	Chemical Formula	Concentration per 100 liter water
DDT-Lindane E.C. 30/9	30% 2,2-Bis (P-chlorophenyl)-1,1,1-trichloroethane + 9% γ -1,2,3,4,5,6-hexachlorocyclohexane.	1000 ml
Diptrex S.P. 80%	0,0 dimethyl(1-hydroxy, 2,2,2-trichloroethyl) phosphonate	500 g
Lebaycid E.C. 50%	0,0-Dimethyl 0-4(methyl mercapto)3-methylphenyl phosphorothioate.	1000 ml
Nexion E.X. 25%	Methyl B-(ethylsulphoxy) ethyl 2,2, dichlorovinyl phosphate	1000 ml
Sevin W.P. 85%	N-Methyl - 1 naphthyl carbamate	500 g
Zolone E.C. 350 g/l phosalone	S, (6-chloro-2-oxobenzoxazolin-3-yl)methyl 0,0-diethyl phosphorothiolothionate.	1000 ml



Fig. 4. Typical date palm sprayed for control of *B. amydraula* with an effective insecticide (left) and an unsprayed palm (right).

among these five insecticides in the percentage of infested fallen fruits or in the average yield per bunch. Diptrex proved to be the least effective insecticide, yet the average yield of trees sprayed with it was significantly more than that of the control.

In testing the time and number of applications, Zolone E.C. 1%, DDT-Lindane E.C. (30/9) 1% and Sevin W.P. 0.5% were used. One spray 10 or 30 days after setting, i.e., when the "June drop" was completed, was enough to control *B. amydraula*. No statistically significant difference was found between one application of any of these insecticides and two or three applications. Nexion and Diptrex required a second application and, therefore, were not economical materials.

Well waters containing up to 6400 ppm of total solids had no effect on the effectiveness of Zolone, DDT-Lindane or Sevin. These saline well waters had no phytotoxic effect on leaves or fruit.

A heavy infestation of mites (*Eutetranychus orientalis* Klein) was recorded for the first time in the U.A.R. in trees treated with Sevin, DDT-Lindane, Nexion and Diptrex, respectively. No increase occurred in the mite population on palms sprayed with the other insecticides or on unsprayed palms. The increase in mite population was probably due to disturbance of the natural balance by decreasing the numbers of predators. This problem needs investigation.

The foregoing results suggest the following recommendations for the control of *B. amydraula*:

1. One application of Zolone E.C. (35% active ingredient) 1% or Lebaycid E.C. (50% active ingredient) 1% should be made 10 days after fruit setting, using a high-volume sprayer.
2. Saline well waters up to the rate of 6400 ppm can be safely used to dilute the insecticides mentioned above.
3. Sanitation must be practiced regularly after harvest to remove all dry fruits, bunches and leaf fiber in order to reduce the population of overwintering larvae.

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FRUIT SET OF DATES AS AFFECTED BY POLLEN VIABILITY AND DUST OR WATER ON STIGMAS

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INTRODUCTION

Work on mechanical application of pollen to the inflorescence of the date palm (*Phoenix dactylifera* L.) has aroused the interest of growers in factors that may affect fertilization and fruit set.

In a test to determine the relation of pollen germination to set of Deglet Noor fruit (1), we found little relation between pollen viability and set of fruit when an excess of pollen was applied. Growers have asked if the results would be the same in different growing seasons and at levels of viability approaching zero. Dust storms, which occur frequently during the pollinating season in the Coachella Valley, California, are sometimes blamed for a poor set of fruit. These storms leave on the flowers heavy deposits of dust from slightly alkaline soils. Thus, dust might influence fertilization by reducing pollen germination or injuring the stigmatic surface of the pistil.

Nixon² found that fruit set was reduced when, immediately after pollination, water was applied to the inflorescence from a sprinkler in a manner that simulated rain-fall.

This is a report of a study of fruit set of the date as affected by viability of pollen used, or by dust or water applied to the flowers.

PROCEDURES, RESULTS AND DISCUSSION

Influence of pollen viability on fruit set. After thinning 20 inflorescences to 40 strands each, we divided them in halves of 20 strands and covered each half with a paper bag. To one half of each inflorescence we applied fresh pollen; to the other half, one of two stored pollens. In tests in a modified Brewbaker and Kwack medium (2), germination percentages of the three pollen lots were: fresh, 74%; P312, 35.5%; and P3, 1.5%. The three kinds of pollen were loaded separately into small dusters. Pollination was accomplished by punching a small hole in each paper bag, inserting the nozzle of the duster and injecting the pollen with a single puff of air. The bags were removed 3 weeks after pollination.

In September we cut five-strand samples from each half of the bunch and determined the percentage of fruit set from counts of fruit and flower scars. The data from this test (Table 1) indicate, at low levels of pollen viability, a definite relationship between viability and fruit set, even when an abundance of pollen was applied.

Influence of dust on set of fruit. To determine the effect of dust from soil blown by wind onto the stigmatic surfaces of date flowers, we applied dust to the flowers with a hand insect-duster. The dust had been deposited by the wind on the surface of some boards shortly before it was collected. It seemed to be composed mostly of very fine silt and clay particles.

Each of the following treatments was applied to 7 inflorescences: (1) dusted and immediately pollinated; (2) dusted and pollinated the next day; (3) dusted and pollinated after 4 days; (4) pollinated but not dusted (control).

Bunches were thinned in the usual manner to 40 strands. In September five-strand samples were cut from each bunch, and the percentage of fruit set was determined from counts of fruit and of flower scars.

Dust had little effect on set of fruit (Table 2). The reduction in set resulting from treatment 3 was due to chance variation within the treatment. The range in fruit set for this treatment was 11.7% to 42.5%.

Influence of spraying inflorescences with water at various intervals after applying pollen. To determine the influence of water on fertilization and fruit set of Deglet Noor dates, we pollinated whole bunches, then sprayed half bunches as follows: (1) pollinated and sprayed with water immediately; (2) pollinated and sprayed with water after 30 minutes; (3) pollinated and sprayed with water after 60 minutes.

Each half bunch was covered with a paper bag after the pollen was applied. One of the bagged halves was thoroughly sprayed with water from a knapsack sprayer. Following the spray treatment a clean bag was placed over the treated portion of the bunch. All bags were removed 3 weeks after pollination.

None of the water treatments caused a significant reduction in the set of fruit (Table 3). Weather conditions favored rapid drying. If the bunches had remained wet for a longer period or had been sprayed several times, enough pollen might have been injured to reduce set of fruit.

SUMMARY

Fruit set on inflorescences of Deglet Noor palms pollinated with pollens of different viability was closely related to the percentage of viable pollen. A coating of dust on the stigmas of date flowers did not interfere with fertilization when pollen was applied up to 4 days after the dust application. Spraying of inflorescences with water at intervals of 0, 30 and 60 minutes after pollination did not affect the set of fruit under conditions favoring rapid drying.

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Table 1. Fruit set on half bunches pollinated with fresh pollen of high viability compared to that on halves of the same bunches pollinated with stored pollen of lower viability

Pollen source	Germination	Fruit set
	%	%
Fresh	74.0	37.9
Stored, P312	35.5	20.1
Stored, P3	1.5	2.2

Table 2. Effect of dust on set of fruit. (Whole bunches treated)

Treatments	Fruit set
	%
Dusted and immediately pollinated	35.0 ¹
Dusted and pollinated after 1 day	32.6
Dusted and pollinated after 4 days	26.0
Control, not dusted	34.9

¹ Differences are not significant at the 5% level of probability.

Table 3. Effect of spraying inflorescences with water at various intervals after applying pollen¹.

Time after pollination before spraying	Sprayed half Fruit set	Dry half Fruit set
	%	%
0 minutes	41.5	37.5
30 minutes	36.1	40.3
60 minutes	28.7	33.4

¹ Ten to 12 bunches each treatment.

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DATE CULTURE IN IRAN

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The date fruit is Iran's most important tree crop, and in some areas of Iran the date is the most important food. The palm tree and date culture were known to the Iranian people in the provinces of Khuzestan and Fars a long time before the Median Empire (708 B.C.) and the Achaemenian Dynasty. Wilson (9), who called the date palm the tree of life, believed that date culture in Mesopotamia and southern Persia went back to earliest times — as long as 7,000 years ago.

The Food and Agriculture Organization (FAO) of the United Nations reported in 1968 (4) that Iran provides 17 percent of the world's date production, thus being the third largest producer after the United Arab Republic (22%) and Iraq (19%). Iran, however, is the second largest date exporter.

According to the latest census (1966), Iran's population is 27.4 million. Of the 8 million employed Iranians, 42% gain their livelihoods in agriculture (2). In approximately 10,000 villages, the people cultivate dates as a primary or secondary crop.

Iran covers an area of 628,000 square miles. Most of Iran is on a plateau about 3,300 ft. above sea level, and most of the plateau is dry, with only 4 to 6 inches of rainfall a year. Plateau temperatures range from 45° C in summer to 0° C in winter. In contrast, a Mediterranean climate prevails in the vicinity of the Caspian Sea — high humidity, rich tropical plant growth, and an average of 79 in. annual rainfall.

Iran's total agricultural areas cover 13 percent of the entire land surface, or 47.8 million acres (2). Date culture covers 307,000 acres, 2 percent of the annually planted and irrigated agricultural land (3). Date plantings are widely dispersed over 52% of the land area. If water for irrigation could be obtained, date cultivation might be extended to cover 10% of the entire land area.

DATE REGIONS, CLIMATE AND PRODUCTION

Most of the date growing areas of Iran are in the 4 southern provinces of Khuzestan, Fars, Kerman, and Baluchistan. Date plantation is primarily in 2 geographic strips. One strip stretches 2,012 km from the Pakistan border in the east to Shat El Arab (Arwand-Rud) in the west and along the Persian Gulf. On the western border, the second strip runs 687 km south from Qasre Shirin in the province of Kermanshah.

The absolute minimum and maximum temperature readings taken in the 4 most important date growing regions of Iran are shown in Table 1 with similar readings from Indio in California and Phoenix and Yuma in Arizona. The temperatures in Ahwaz and Abadan regions (Khuzestan) correspond most closely to those of Indio and Yuma. The temperature extremes in Bam and

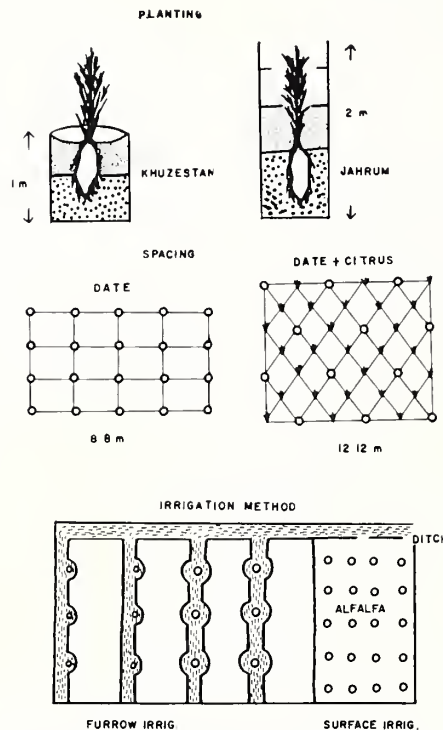


Fig. 1. Top row, date planting methods. Middle row, date tree spacing. Bottom row, irrigation methods.

Bandar-Abas (Kerman) more nearly match those of Phoenix (Table 1).

The major date regions of Iran have a very dry climate — little humidity and rainfall extremes ranging from 2.5 to 8.0 inches, most of the rain falling in winter. Because of the very low humidity, there is no checking and blacknose damage of dates, nor are paper covers used. Hot winds of 50 mph or higher are not uncommon in the Iranian desert areas. Date palms are often used as windbreaks to prevent the hot winds and accompanying dust from severely or even totally damaging citrus and vegetable crops.

Number of Date Palms and Production. It is extremely difficult to obtain production data because many Iranian growers consume their own date harvest. An FAO estimate of Iran's total number of palms and production in different date regions is given in Table 2 for 1963. As shown in that table, the production of 21.6 million date palms (including male, female, and nonbearing trees) was around 325,000 metric tons. For the past 10 years Iran's annual date production according to different estimations has varied from 616 to 770 million lb. The ratio of male to female palm trees under an intensive management should be, according to Ashtari (1), 5% and, according to Nixon (7) only 2%. In Iran, however, roughly 25% (5 to 6 million) of the date palms, are male. This is one of the several reasons for the low yield per acre in Iran compared with other countries.

DATE CULTIVATION

Planting Methods. Date offshoots for planting are usually removed from the mother date palm after 5 to 7 years of growth. They weigh 15 to 20 kg, and have at least 10 green leaves. Two date planting methods are used. The first, used primarily

Table 2. Number of date palms and production of dates in different provinces of Iran (1963)¹

Province	Palms in 1,000	Metric Tons
Khuzestan	5,726	85,890
Fars	4,900	73,500
Kerman	6,776	101,640
Baluchistan	3,703	55,545
Other provinces	539	8,070
Total	21,643	324,645

¹ FAO Report 1964 (3).

in Khuzestan, consists of placing the offshoot into a hole 1 m deep and 1 m in diameter and filling in with a mixture of top soil and animal manure (Fig. 1). When

Table 1. Date region temperature extremes, Iran and U.S.A.^{1, 2}

Region	Absolute minimum, °C					Absolute maximum, °C				
	Nov	Dec	Jan	Feb	Mar	May	Jun	Jul	Aug	Sep
Bam	- 1.5	-6.0	- 8.0	-4.2	- 2.5	42.0	44.6	45.6	42.6	41.2
Bandar-Abas	13.3	7.2	3.3	8.8	10.5	41.6	48.3	45.5	42.2	39.5
Abadan	—	0.8	- 4.5	-5.0	—	48.0	50.0	50.0	50.2	48.9
Ahwaz	0.0	-3.0	- 7.0	-5.4	0.0	47.8	51.0	54.0	50.3	47.3
Indio	- 5.0	-8.3	-10.5	-6.7	- 2.8	49.4	49.4	51.6	49.4	50.0
Yuma	- 4.4	-5.5	- 5.5	-2.8	0.0	46.1	48.8	48.3	47.1	46.1
Phoenix	0.0	-1.1	- 7.2	-3.3	- 1.7	40.5	45.5	45.5	45.0	42.7

¹ Years of record: Indio, 64; Iran, 10.

² K.W.P.C. Rept. 1969 (8).

¹Presently on sabbatical leave and engaged in research program in the Department of Plant Sciences, College of Biological and Agricultural Sciences, University of California, Riverside.

the soil is heavy, sand is added to the fill-in mixture.

The second method is used more in the Jahrum district of Fars. The planting hole is at least 2 m deep to facilitate the uptake of groundwater. Three separate fill-ins of soil and fertilizer are normal during the first year of planting. In one to 2 years, leaves from the planted palm rise above ground level. The second method offers better soil moisture and rain water utilization and also results in better root development. Trees planted by the second method in Jahrum yield date crops 4 to 5 times as large as the crops from trees planted by the first method. In Jahrum a yield of 300 lb per tree is not uncommon. Even though the cost of planting by the second method is double that of the first, subsequent savings in irrigation, better water penetration (especially in heavy soils), and higher crop yields more than compensate for the higher initial cost (6).

Spacing and Interplanting. There are still some old plantations where slow-growing varieties like Khadrawy were planted less than 8 m apart (in the form of a square), but now most plantings are made at least 8 m apart (Fig. 1). When citrus trees are interplanted with date palms, as is often done, the palms are spaced 12 m apart, in the form of an equilateral triangle. With both types of spacing, there is enough air movement among the trees to prevent humidity damage.

If soil is good, enough water is available, and there are no salinity problems, growers in Iran tend to interplant citrus with dates, and, for the first 10 years, maintain a cover crop such as alfalfa or clover, or cultivate vegetables among the trees. Interplantings are made for economic reasons as well as for protecting crops. Three cash crops enable the farmer to afford good land management and fertilization. The cash income from dates alone — usually from \$80 to \$140 per acre — does not cover expenses, whereas citrus brings 3 to 4 times as much. In areas of high winds, good citrus yield is ensured by interplanting date palms as windbreaks. The palms shade the citrus and provide protection against frost and wind. Interplanting dates and citrus does, however, present difficulties related to different water requirements and the use of mechanized agricultural equipment.

Irrigation. Water sources and types of irrigation differ so in the individual provinces that they cannot be discussed in detail here. Generally, irrigation in most of the date-growing areas is irregular. Water obtained from rivers that rise in the mountains is carried in permanent irrigation canals, as in Khuzestan from the river Karun and in Kerman from the Minab. Thousands of pumping stations also supply water from rivers and wells. In some areas the underground water level is so high that date palms use it directly.

Most of the date growing areas have a relatively heavy and saline soil with conductivities of 3 to 15 mmhos/cm — especially so in Khuzestan—but fortunately date palms are resistant to salinity. Furr and Armstrong (5) found that below 24 mmhos/cm salinity does not affect palm leaves, date size, or tree yield. In Abadan sea water is utilized as a source of irrigation. High tides move the water into channels and thence into plantations. After many years of salt accumulation, however, the date palms suffer from salt injury and become increasingly nonbearing (3).

Irrigation problems occur mostly in sum-

mer. Although the irrigation interval is 10 days, the amount of water carried in furrows (3 to 4 in.) is not enough to penetrate the optimal 6 ft. for heavy soil. This is one reason for unsatisfactory date yield. Furrow irrigation is usually used for the first 15 to 20 years of a plantation. Then furrows are widened and deepened into ditches, and the palms stand on little islands in these ditches. Surface irrigation, or flooding, is the best watering method and permits a cover crop, but a relatively large source of water is required.

Fertilizers. Formerly the only nutrients applied in date plantations were 20 to 30 kg of animal manure per tree once every one or 2 years. In the past 10 years, though, 2 chemical fertilizer factories have been established in Shiraz and Bandar Shapur. The use of chemical fertilizers is constantly increasing, with much of the impetus originating with the land reform of 1962 when tenants took over land ownership and became interested in more intensive land management. Experiments with many types of fertilizers are conducted in the agricultural colleges of Ahwas province and at 2 date research stations.

Pollination. The time of pollination in the 4 major date producing provinces is roughly from the middle of March to the end of April. Pollination is done by hand. Three to 4 strands of freshly opened male flowers are carried to the female cluster, which should be pollinated not later than 5 days after opening. If rains fall during pollination time, the process of dry pollination is employed. Dusting is used only by large commercial date gardens to obtain a 100% effective pollination.

Pruning. Optimal pruning management consists of several steps. All but 5 offshoots are removed from each date palm. All dead leaves are cut out, including those hanging down, while the stalk is still green; otherwise, the stalk base dries and openings which can harbor insect pests develop. After 2 years, the leftover leaf stalk base is also removed with the fiber so that the stem is clean and smooth.

Fruit Thinning. As long as the Iranian farmer consumes most of his own dates, he is concerned not so much with quality as with quantity. Since fruit thinning increases quality but probably reduces yield, it is practiced only when high quality is desired. In the Jahrum district generally, and with some varieties in Khuzestan, if a palm has more than 12 bunches with a good fruit set the grower removes one or 2 bunches at the beginning of the green stage.

Pest and Weed Control. The department of pest control of the Agricultural Ministry

and the Institute of Plant Protection have been very active in the last 10 years, and all date plantations are now under their supervision and receive spray material and even spray machinery. Despite all current efforts, however, the date mite, *Oligonychus pratensis* Banks, known in Iran as "Kanneh," is still one of the most serious pests and causes much damage. Sulfur application is used at least 3 times a year to fight it.

Date scale, *Parlatoria blanchardi* Targ., called "Shepeshac," also occurs. Sometimes young leaves are entirely covered by scale and are severely injured. Date scale is combatted with phosphor solutions like parathion and malathion.

The lesser date moth, *Batrachedra amydraula* Meyr., is another serious pest in Khuzestan. It is a new introduction, and several experimental studies are under way in Teheran to find the best means of control. Of lesser importance is the "Sanjere", *Omatissus binotatus* Fieb., which occurs in Kerman and is controlled with any type of insecticidal spray.

Imerata cylindrica (L.), known as "Halfeh", is without doubt the most serious and dangerous weed in Khuzestan. A quick-growing stiff grass, it can kill young palms, stop growth of adult palms, and reduce date yield. The rhizome breaks through the soil, covers the ground quickly, and attacks palm roots. Despite much experimentation with all kinds of herbicides, no economically feasible method has yet been found to control this weed. The most effective method is still harrowing, collecting the cut rhizomes, and planting alfalfa (3).

THE HARVEST

Varieties. The date varieties of Khuzestan are about the same as those of Iraq. The Saamaran, also known as Sayer, is the most common variety — 80% of the total crop of Khuzestan — and is the chief export date of Iran. Although eaten as a soft date, mostly it is processed as a cured date. It is a late ripening medium-sized date, with a good yield of usually 12 bunches, and is less susceptible to mites than are other varieties. Three harvesting operations are the norm for one season. The Khadrawy — 8% of the Khuzestan crop — is an early, soft date, slow growing and yielding less than the Saamaran, with considerable fruit fall. The Dayri at 3% is the third most common variety in Khuzestan, with the Gantar, Halawy and Broom varieties at 2% each. Other varieties make up the remaining 3% of Khuzestan's total crop.

Date varieties are harvested at varying stages of maturity. Some varieties taste best

Table 3. Iran's most common date varieties, listed in order of importance¹.

Khuzestan	Fars	Kerman	Baluchistan
Saamaran ***	Shahani ***	Shahdad ***	Mozafati ***
Khadrawy **	Kabkab **	Mozafati ***	Raabi **
Halawy *	Dagelzard *	Mordsang **	Shekari *
Dayri *	Zahedi *	Zareik *	Kermani *
Gantar *	Lasht *	Karut *	Deski *
Zahedi *	Shakar *	Porku *	
Kabkab *	Zamardan *	Bazmi *	
Dagelzard *	Maktib *	Abdolahi *	
Dagelmussa *	Khasui *	Lasht *	

¹ *** = most important;

** = very important;

* = important.

when harvested in the **khalal** stage for use as a fresh date or boiled (**khaarak**). Some varieties taste best when harvested in the **rutab** stage for consumption as a soft date, and others in the **tamar** stage for processing as cured dates. The Broom, for instance, is harvested only in the **khalal** stage; Dayri and Zahedi only in the **tamar** stage. But many varieties are harvested in all 3 stages. In Khuzestan 10% of the dates are harvested when in the **khalal** stage, 10% **rutab**, and 80% **tamar**. This is also the usual consumption form for the other provinces.

Even though about 400 varietal names are used, there are actually only 50 to 60 date varieties in Iran. The same variety often is called differently in different locations. Table 3 lists the most common varieties in order of their importance. The characteristics of all varieties can not be discussed here, but a few of the most important will be mentioned.

In the Jahrum and Minab districts of Fars and Kerman, the early bearing Shahani is widely planted. It yields profusely and provides the most expensive date, which is consumed mostly either soft or cured. It is very sweet in the **khalal** stage. Known as unfertilized dates, the Mazafati are the most common dates in Kerman and Baluchistan. Trees are heavy yielders, and the dates are usually harvested in the **tamar** stage. Kabkab, grown along the Persian Gulf, is the best variety for storage and is harvested in the **rutab** and **tamar** stages.

Harvesting and Packing. Date harvesting in Iran starts at the end of July, primarily with the gathering of dates to be consumed in the yellow or **khalal** stage. The harvest extends to the end of September, when the late maturing varieties and the **tamar** stage dates for curing are removed. Harvesting is manual. Usually whole bunches are cut and the dates used in the dry, boiled or fresh yellow stage. For a soft or mature date, however, 2 or 3 pickings may be needed to complete the harvest and obtain the dates at the desired maturity. The bunches are placed in wooden boxes or in baskets made from date palm leaflets. Dates for export are sent to packinghouses, and those for the home market are packed mostly in the field. More than half of the Iranian date production is processed in the field. First hand grading removes the rotten fruit and separates the **khalal** and **tamar** dates. If field fumigated, the dates are covered with a tarpaulin and then treated with phostoxin or methyl bromide. If post harvest ripening is desired, the date bunches

are hung in a separate room until mature. Another procedure is to place the dates on mats or wooden boards and dry them in the sun. The dry dates are packed in paper bags or paper sacks. The soft dates are pressed into 50 kilo baskets.

Of the 8 packinghouses in Iran 7 are situated in Khorramshahr, a Persian Gulf port in Khuzestan. At the packinghouse the dates are removed from the bunches, fumigated and hand graded on a conveyor belt. Some are pitted by hand or by machinery from the USA. Dates are packed in 1.5 lb cellophane bags, variously sized paper cartons, or wooden boxes, the size and type of package being determined by the importing country.

Date Export. About 10% (60 to 70 million lb) of Iran's annual date production is exported from the port city Khorramshahr to the USA, Canada, USSR, Germany, and Holland. Nearly 50% (12 million lb) of the USA's date import comes from Iran. An estimated additional 10% of Iran's production, as dry dates packed in paper sacks or burlap bags, is shipped from small ports to India, Pakistan, South Africa, and islands in the Persian Gulf.

About 500 million lb of dates are consumed in Iran annually. This means a per capita consumption of 18 lb a year. Date consumption is far higher in rural areas — especially in date-growing regions — than in the cities.

Yield per tree. The yields per palm and per acre differ widely in the various regions of Iran, much of the difference arising from varietal characteristics. The Saam-aran variety yields 80 to 170 lb per tree in Khuzestan, and the Shahani may yield from 150 to 300 lb in Fars and Kerman. However, according to Ashtari (1), the average yield of bearing palms (75% of total palms) in Khuzestan is 72 lb per tree and in Fars and Baluchistan about 60 lb. The average yield over the past 10 years from 15 million bearing palms was only 45 to 50 lb per tree. Reasons for low yields per tree are mostly poor soil, insufficient water, inadequate fertilization, and a lack of intensive management. An additional reason for the low yield per acre in Iran as compared with yields in other countries is that roughly 25% of Iranian date palms are male.

FUTURE DEVELOPMENT

Land reforms providing for grower ownership of plantations have already resulted in better management as far as irrigation,

fertilization, and pest control are concerned. The date grower can now obtain funds from agricultural cooperatives and agricultural banks. No longer is he beholden to a landlord.

For the 5-year plan of 1968-1973, the government of Iran budgeted a generous amount of money for the further development of date culture. New packinghouses and modernization of old ones have priority. Plans call for increasing Iran's date crop through a higher yield per acre and through establishing new plantations. Export marketing to Europe and the USA is to be expanded, and efforts are being aimed at widening Iran's markets in the East, where the population is burgeoning.

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FRUIT COUNTING AND FRUIT THINNING IN SIX DATE VARIETIES OF IRAN

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Fruit thinning results in larger fruit size and better quality and fosters annual bearing. There are several excellent publications on date thinning of Medjool and Barhee (4) and on the relationship between leaves and fruit production, mostly by Nixon (5), and application of chemicals for date thinning by Furr and Hewitt (2). Unfortunately, it is not always possible for other countries with different climate, soils, varieties and management to use the results of these studies. In Indio, California, the date palm carries 140-150 green leaves (3). In Khuzestan the date palm regularly carries 50-80 green leaves. This is less than the number needed for photosynthetic production to support 8-12 bunches which are commonly grown in Iran.

Date fruit fall poses a serious problem in Khuzestan. Primary studies on fruit thinning on the Saamaran, Khadrawy and Dayri varieties were started by the Agricultural College in Ahwaz. After two years it was realized that a detailed study on fruit fall was necessary for better knowledge of fruit set, fruit drop and variety characteristics. A large fruit counting project was started in 1968, the results of which are reported herewith.

Fruit Thinning: Generally fruit thinning is not practiced in Iran. If, however, there is a good fruit set and more than 12 female clusters the grower will remove one or 2 bunches. The methods of taking strands from bunches or cutting back the tips of bunches is not used.

In our fruit thinning experiment made in 1966 and 1967 on the Saamaran, Khadrawy and Dayri varieties, 3 different treatments were applied to each of 5 date palms. The first treatment involved bunch removal thinning based on a leaf-bunch ratio of 9 to 1. In the second treatment, one-third of the flower clusters were cut back at pollination time. In the third treatment about one-third of the strands were cut from the center of the bunches in the month of June, approximately two and one-half months after pollination.

The results of cutting back the flower cluster and of removing the center strands have been negative. Not only was the yield greatly reduced (in some cases as much as 50%), but the harvested fruits were either too mature or immature. The latter stopped normal growth and did not reach the khalal, rutab and tamar stages. Almost all fruits were shriveled and not salable.

The bunch removal treatment had a far better effect on size and reduction of fruit fall. Because of the rather high leaf-bunch ratio of 9:1 which was selected, only one

or 2 bunches per palm were removed. Even though the difference between thinned and non-thinned palms was not large, thinning reduced fruit drop 10%.

According to the above results, the cutting back of the flower cluster and the removal of center strands, at least with large fruited varieties, is not to be recommended as a thinning method in Khuzestan. Only the bunch removal with the proper leaf-bunch ratio for each specific variety can be used without any damage to the quality of fruit. The proper leaf-bunch ratio should be established for each variety in further tests. It probably should be lower than the above-named ratio.

Before any recommendation about thinning can be made, the varietal characteristics such as fruit set per bunch, fruit drop and the optimum leaf-bunch ratio should be known. To achieve this goal a large fruit counting experiment was undertaken in 1968.

Material and Methods: For this experiment 20 date palms of each of 6 varieties were chosen. The varieties were divided into 2 groups. Group one included those 3 commercial varieties which cover 90% of the date plantings in Khuzestan and also include both early and late maturing varieties and different consumption forms, namely Saamaran, as the most widely distributed soft and cured date; Khadrawy as a middle-sized early and soft date; and Dayri as a late and large-sized dry date. The second group consisted of 3 small fruit varieties which are completely different from the commercial varieties, namely the early Belyani consumed in the khalal stage, the late Dagelmussa consumed in the tamar stage, and the medium-sized, mid-late Dagelzard used as a cured date variety. The palms chosen were 25 years old and uniform for each variety. They had received the same management as far as irrigation, pest control, pollination and pruning are concerned. The pruning practice consisted of removing the dead leaves and those below the flower clusters.

Fruit Counting: The fruits and the strands of each individual bunch were counted in 3 different stages of ripening. The first counting was made between July 15-20, sixteen weeks after pollination. This was in the kimri, or green stage. Counting at an earlier date was unfeasible because of the compactness of the fruit bunches. The second counting was performed August 15-20, thirty days later when the fruit was in the khalal, or yellow-red stage. The third counting was made September 15-30, five to seven weeks later at harvest time. Fruit counting of soft dates at this stage was made by getting the average weight of 100 fruit and dividing into the total yield of each palm. The dry dates were counted.

RESULTS

Bunch, strand, fruit relationship: Data summarized in Table 1 show very clearly the relationship of the number of bunches per palm and the total number of fruit counted per bunch 16 weeks after pollination, in the green stage. With most varieties there was an indirect relationship between the number of bunches per palm and the amount of fruit per bunch (Fig. 1). The variety Belyani with an average of 7.8 bunches showed 2129 fruit per bunch, while Saamaran with an average of 12.3 bunches had only 896 fruit. This indicates that thinning fruit by bunch removal or thinning on bunches would have the same effect. An exception is the Dayri variety, which has a relatively small number of bunches and a relatively small number of fruit per bunch. In Khuzestan this is well known as a variety with large fruit.

Reports by research workers in the United States recommend 20 fruits per strand and 45 strands per bunch for Medjool and Barhee (4). Accordingly, the 3 commercial varieties reported in Group I have a satisfactory number of fruit per strand. The number of strands per bunch, however, would require light thinning if the conditions are assumed to be the same in both countries and for the different

Table 1. The average number of bunches per palm, strands per bunch, fruit per strand and total fruit per bunch on six different date varieties in the green stage¹.

	GROUP I			GROUP II		
Varieties	Saamaran	Khadrawy	Dayri	Belyani	Dagelmussa	Dagelzard
Bunches						
per palm, no.	12.3	8.9	9.5	7.8	12.0	8.7
Strands						
per bunch, no.	51.5	56.5	48.6	79.8	85.4	62.0
Fruits						
per strand, no.	17.5	18.9	11.6	26.6	37.7	20.2
Total fruits						
per bunch	896	1,058	558	2,129	1,699	1,255

¹Presently on sabbatical leave and engaged in research program in the Department of Plant Sciences, College of Biological and Agricultural Sciences, University of California, Riverside.

²I would like to thank Mr. Ebrahim Pazira and Mr. Kazem Farbod for valuable assistance concerning statistical analysis.

¹ Average of 20 date palms each variety (± 200 bunches); data significant at 1% level.

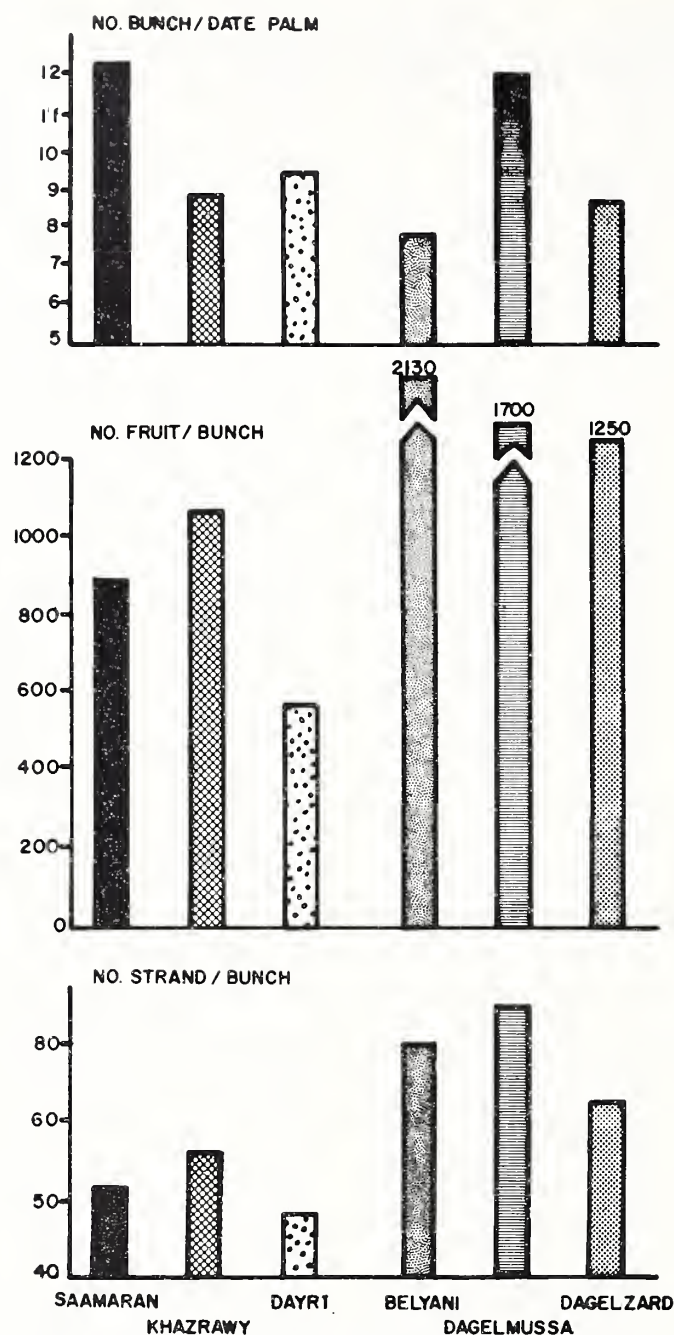


Fig. 1. Bunch, fruit, strand relationship. Top row, number of bunches per variety of date palm. Middle row, number of fruits per bunch. Bottom row, number of strands per bunch.

Table 2. Fruit counting and percentage of natural fruitfall by six different dat varieties¹

Varieties	GROUP I			GROUP II		
	Saamaran	Khadrawy	Dayri	Belyani	Dagelmussa	Dagelzard
Total fruits/tree (1st counting), no.	10,746	9,350	5,375	16,824	18,301	10,464
Total fruits/tree (2nd counting), no.	7,392	6,442	4,062	9,491	12,026	6,510
Fruitfall in 30 days, %	22.1%	30.7%	24.4%	35.7%	34.5%	33.9%
Total fruits at harvest, no.	6,007	2,497	3,300	5,502	9,991	4,800
Fruit weight, grams	9.1	10.3	10.2	5.1	5.0	8.1
Total fruitfall, %	44.1%	73.3%	38.5%	67.3%	45.9%	54.1%
Total yield, kg	54.7	25.8	33.8	27.7	49.5	38.9

¹ Average of 20 date palms each variety (± 200 bunches); data significant at 1% level.

Table 3. Average number of fruitfall per day per tree

Varieties	16-20 week	21st week-harvest
Group I		
Saamaran	112	69
Khadrawy	96	163
Dayri	44	25
Group II		
Belyani	241	133
Dagelmussa	209	77
Dagelzard	132	57

varieties. In the small fruit-size varieties (Group II) the situation is completely different. Under the recommended thinning practice the Belyani and Dagelmussa varieties with 80-85 strands and 26-37 fruit per strand would require heavy thinning. This would be expected to reduce fruit dropping and increase fruit size (Table 1). Furthermore, there is a direct relationship between the number of strands per bunch and the number of fruit per stalk (Fig. 1).

Fruit Dropping: As indicated, the main purpose of this experiment is to obtain the amount of natural fruit fall at different stages during the developing and ripening process. In Table 2 are summarized the data for the 6 date varieties from the green through the yellow or red stage (khalal) to maturity. During the first 30-day period (from 16-20 weeks after pollination) at the end of the green stage, Saamaran showed the lowest rate of fruit drop. It had a drop of 22%, or a little over 3,000 fruit per palm. While the Khadrawy lost about the same amount of fruit, it was over a 30% loss because of the smaller number of fruit on the tree. The Dayri lost a little over 1,000 fruit, over 24% of the fruit at the first counting. In the same period the small-fruited varieties in Group II lost about 34%, or between 4,000 and 7,000 fruit in the 30-day period. A comparison of the total number of fruit per palm at the first counting and at harvest time indicates the total quantity of fruit lost. Saamaran and Dayri, 2 late varieties, showed a fruit drop rate of more than one-third of the original count made July 15-20. This may not be unusual for an unthinned date. The dropping rate before this time could not be determined because of the difficulty of counting the fruit sooner in the small compact bunches. The early soft date, Khadrawy, in this same period, showed a dropping rate of 73%, the highest rate in this experiment. This means that during the 2.5 months of ripening there was a loss of almost 7,000 fruit from the original count of 9,350. A heavy thinning of 40-50% could produce an increase in both size and yield for this variety as indicated in a previous thinning study by bunch removal.

In the small-fruited varieties (Group II) the early variety, Belyani, mostly eaten in the khalal stage as fresh or boiled dates, kharek at harvest, showed a loss of almost two-thirds of the fruit from the first counting. This was a loss of more than 11,000 fruit in the 10-week period. Dagelmussa and Dagelzard dropped about one-half the fruit but yielded comparatively more per tree.

From data in Table 2 it can be seen that, as expected, the small fruited varieties showed generally a higher percent

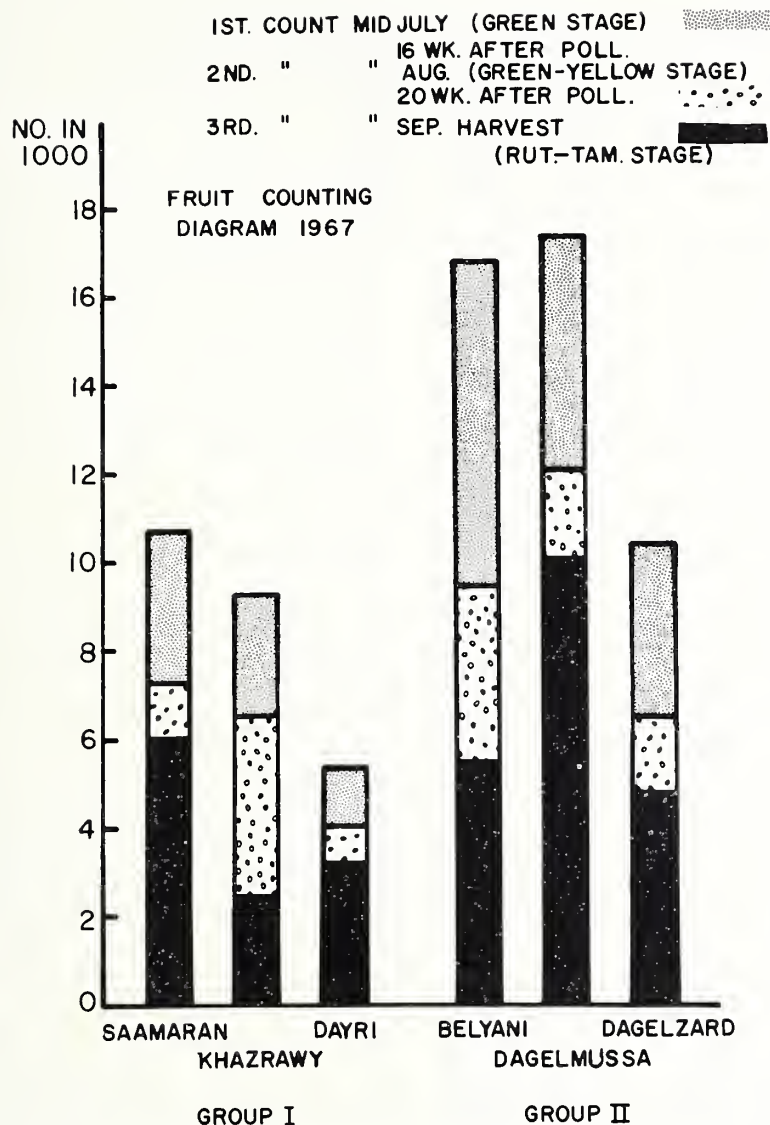


Fig. 2. Average fruit drop per palm during the periods of: 16-20 weeks after pollination (green stage), 20-24 weeks after pollination (yellow-red stage), and the remaining fruit harvested at maturity.

of dropped fruit (Group II) when compared with the relatively large commercial varieties (Group I). The only exception is Khadrawy, a middle-sized, early, soft date which has a high percentage drop. In Fig. 2 are shown the loss of fruit in each period and the amount of fruit harvested.

The fruit fall per day in the 2 periods during which counting was made is shown in Table 3. It can be seen that during the 30-day period (16-20 weeks after pollination in green stage) in both groups fruit fall per day was almost twice the loss of fruit in the second period to harvest (5-7 weeks later). Again the Khadrawy was an exception showing a larger drop in the second period. It went from a fruit drop of 96 in the first period to 163 in the second. While data are not available, the greater loss of fruit by this variety in the second period is believed to be due to several factors which do not apply to the other varieties. It is an early, good tasting soft date and bird damage may be involved. It is recommended that during the last 6-8 weeks before harvesting bunch covers be applied.

The greater fruit drop in most varieties

in the green state is due to the largest volume and weight accumulation and increase in sugar during this stage of the date development (1). At this time the date palm in Khuzestan has difficulty meeting this maximum nutrient need with the relatively low leaf-bunch ratio and poor soil fertility. The large drop of fruit by all varieties in this period is a serious loss to the palm. In Group II the small-fruited varieties dropped from 132 fruit for the Dagelzard to 241 fruit per day for the Belyani. This compares with the large-fruited varieties of Group I in which Saamaran lost 112 fruit and Dayri lost 44 fruit per day. From these data the importance of fruit drop and accompanying loss of nutrients during the 2.5 month period from green stage to harvesting is indicated.

Yield and Fruit Drop: The large amount of fruit drop in all varieties was due to many factors. Certainly the lack of artificial thinning is not the only cause of poor production. Many other factors like lack of proper nutrients, poor soil, unsatisfactory irrigation, improper fertilizer program, insufficient number of green leaves are involved. However, through a fruit thinning program based upon the right leaf-

bunch ratio which must be determined for Khuzestan conditions, the amount of fruit drop may be reduced by a large amount. The potential productivity of palms is of course related to the characteristics of the variety. A comparison of the natural fruit fall with the harvest yield per tree (Fig. 3) indicates that with the Group I varieties, Saamaran, Khadrawy and Dayri, the high percentage drop is related to the low yield. The same relationship can be found in Group II but to a lesser extent. This means that a large amount of fruit drop can be prevented by fruit thinning. In addition, a higher yield is expected if the fruit thinning is done at the right time, not later than 10 weeks after pollination.

SUMMARY

Date fruit fall poses a serious problem in Khuzestan. In a previous 2-year study of thinning methods (1966-67) made at the Experiment Station of Jundi Shapur University, College of Agriculture at Ahwaz, bunch removal thinning, cutting back of flower clusters and removing strands from the center of the bunches were tried on the 3 varieties, Saamaran, Khadrawy and Dayri. Results of that work indicated that a detailed study of the time and rate of fruit fall, fruit set and other variety characteristics was necessary. So a detailed fruit counting experiment of 6 different varieties was started in 1968: Saamaran, Khadrawy and Dayri, the 3 important commercial varieties (90% of the plantings); and Belyani, Dagelmussa and Dagelzard representing 3 small-fruited varieties. Twenty palms of each variety were used. The number of fruit per strand, per bunch and per palm were counted 16 weeks after pollination (kimri) and again 30 days later (khalal) and at harvest time 5-7 weeks later (tamar).

Thinning by cutting back the flower cluster and by removing the center strands reduced both yield and fruit quality of the 3 commercial varieties. Bunch removal, however, is an effective treatment if it is made with a proper leaf-bunch ratio, which may be different for each variety. The 9:1 leaf-bunch ratio used in this experiment seems to be high for Khuzestan conditions for the Saamaran, Khadrawy and Dayri varieties. It is believed at the present time that a rate of 7:1 produces a good thinning effect when applied not later than 10 weeks after pollination.

This study of the bunch-strand-fruit relationship shows an indirect relationship between the number of bunches per palm and the number of fruit per bunch. Large-fruited varieties have more bunches but fewer fruit per bunch than small-fruited varieties. Furthermore, there was a direct relationship between the number of fruit per bunch and the number of strands per bunch.

The fruit drop rate was determined by counting a total of 2,981,600 fruit at the 3 stages on 120 date palms. Results are statistically significant at the 1% level.

Saamaran showed a drop of 44% (4,700 fruit per palm) during the 2.5 months development period from green stage to harvest. Dayri in this same period lost 38% (2,200 fruit); Khadrawy lost 73% (nearly 7,000 fruit), the highest loss of any variety. In the small-fruited varieties Belyani had 67% loss (11,000 fruit), Dagelmussa lost 46% (8,000 fruit) and Dagelzard lost 54% (5,000 fruit). The small varieties in general had a greater number dropping. Furthermore, the rate of fruit drop at the green stage was found to be twice that during the later development.

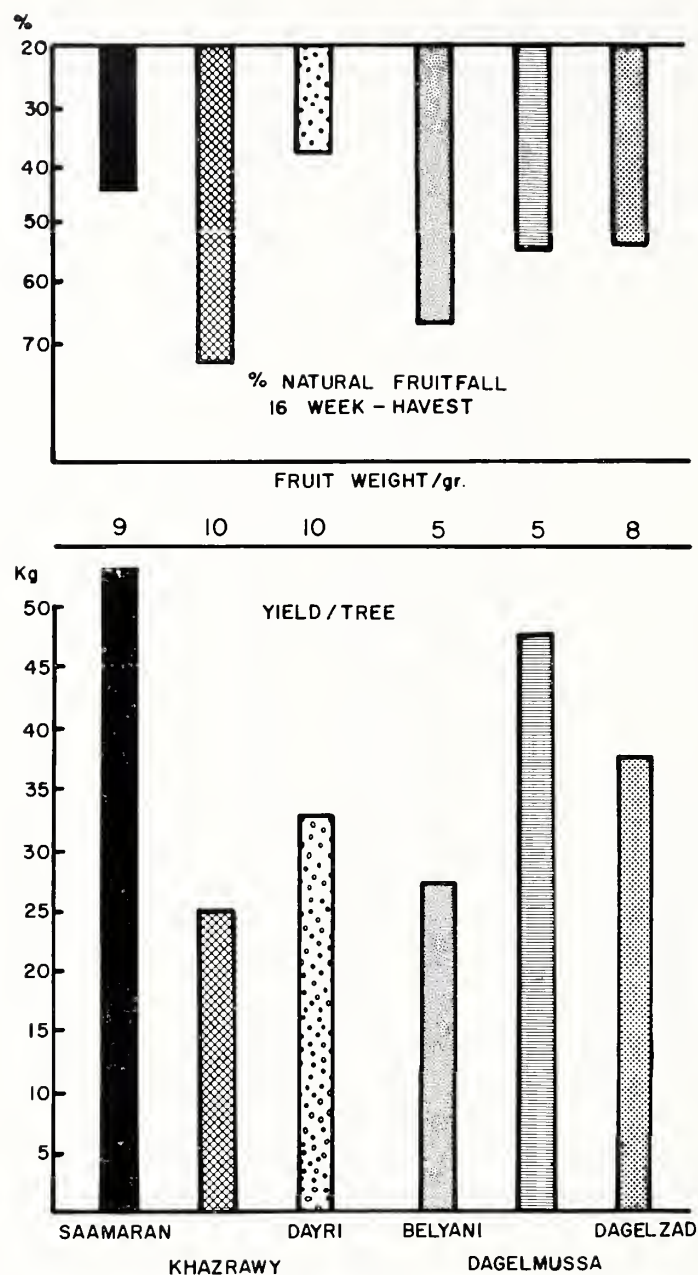


Fig. 3. Relationship of natural fruit fall to yield. Top row, percent fruit fall in 6 Iranian date varieties counted from the 16th week after pollination until harvest. Bottom row, the yield per tree in kg in 6 Iranian date varieties.

According to a previous thinning and fruit counting experiment, some fruit thinning is needed for good production. With the commercial varieties bunch removal should be 40-50% for Khadrawy and 20% for Saamaran. Because of the small number of bunches produced on Dayri none should be removed. The thinning would be expected to reduce fruit fall, increase date size, conserve the nutrients manufactured by the date palm and increase yield.

The small-fruited varieties, Belyani and Dagelmussa, require heavy thinning. Bunch removal is not desirable because of the small number of bunches (7-9). It is believed that removing strands or individual

fruit thinning on the strands may be more desirable.

It is apparent from this study that there is a great loss of nutrients and reduced efficiency of the date palm from the excessive fruit fall during the development of the fruit. Proper thinning and improved cultural practices should reduce the drop and increase the yield.

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MECHANICAL POLLINATION EXPERIMENTS WITH THE DEGLET NOOR DATE PALM IN 1969

G. K. BROWN, R. M. PERKINS and E. G. VIS¹

Experiments using ground-level equipment for applying pollen to Deglet Noor date palms (1) were continued in cooperative studies by the U.S. Department of Agriculture and University of California. The Field Committee of California Date Growers' Association provided a 17-acre date garden in La Quinta, California, for these experiments. This garden had 3 separate blocks of palms which we classified as tall (35-45 ft to the bloom area), medium (25-35 ft), or short (5-25 ft).

EXPERIMENTAL APPROACH

We designated 5 plots of about 1 acre each for separate pollination treatments in each block. One of the 5 plots was hand pollinated; 2 were pollinated mechanically by the bloom duster method (1); and the remaining 2 were pollinated mechanically

by the palm duster method (1).

Hand pollination consisted of dusting each bloom with dry pollen and then placing a pollen-saturated cotton ball in the center of the bloom and a brown paper bag over the entire bloom. These plots were pollinated on March 31, April 17, and May 1. All blooms were thinned the usual amount by end-cutting and center-cutting the strands.

The bloom duster method was the same as used in 1968. One plot in each block was pollinated once/week and the other, twice/week. By this method about 1 acre/hr was pollinated in tall palms and 1½ acre/hr in short palms. About 2½ - 3 quarts of pollen per acre was applied during the 6-week season. None of the blooms were thinned, except in part of the tall-palm plots.

The equipment used with the palm duster method was redesigned. A fork-lift mast was added in order to control the distance between the duster nozzle and bloom area, and a 1-inch diameter nozzle was used to reduce the air velocity at the nozzle to 300 mph. A ground speed of 1½ mph (2½ acre/hr) was used in each plot pollinated twice/week and ¾ mph in each plot pollinated once/week. The flour-pollen mixture was metered at 6.2 in³/min so that 3 quarts of pollen per acre would be

applied to all plots during the 6-week season. None of the blooms were thinned.

To obtain data on fruit set for blooms mechanically pollinated on the same date and at the same approximate stage of development, we tagged all blooms in 16 selected palms and noted the stage of development of each bloom at weekly intervals. Air temperatures were continuously recorded in the bloom area of these palms.

The viability of pollen used with the mechanical pollination methods averaged 73% and ranged from 55 to 86%. We conducted tests to determine whether the pollen might be damaged as the flour-pollen mixture was conveyed through the pipe system and nozzle of the palm duster. The mixture was recovered in a filter-bag at the nozzle exit; then the pollen was separated from the flour and germinated. We found no reduction in pollen germination due to conveying the mixture through either the short or long dusting pipes.

All plots were mechanically harvested between November 20 and December 1. We harvested the tagged bunches in each plot individually to determine their fruit set. The total number of all palms and bunches in each plot was recorded. All bunches on 8 palms in each plot were measured (1) to determine average bunch size (inches of strand). From the receiving



Fig. 1. Palm duster designed for pollinating short to tall palms. Right: using long dusting pipe and fork-lift mast in pollinating tall palms. Left: using hand-held dusting pipe in pollinating short or medium palms.

records for each plot, California Date Growers' Association provided us the information on unpollinated fruit, fruit size, fruit quality, and yield. We compared all plots for fruit set, yield, and grower return. Finally, we estimated how much each plot should have been thinned to produce 70% "marketable" yield.

RESULTS

Application schedule. Mechanical application of pollen started on March 31 and continued through May 16 (Figs. 2-4). The bloom duster maintained the desired schedule in the tall and medium-palm blocks. However, because irrigation water frequently prevented operation of the bloom duster in the short-palm plots, we removed them from the experiment. Irrigation water in all blocks prevented proper operation of the palm duster until April 10.

Weather conditions. The daily maximum temperatures which occurred during the period of pollination (Figs. 2, 4) were very favorable (usually 80°F or above) for good fruit set. Rain and low temperatures occurred May 4-7, but nearly all of the blooms were pollinated before then.

This year had more than the normal frequency and intensity of wind (2). The air at this ranch usually stayed calm until 9:00 a.m.; then wind gradually increased in intensity and gustiness until late afternoon. Pollen application in the short palms was affected most by wind because the tall palms were always pollinated first, the medium palms next and the short palms last. Application continued as long as the wind did not prevent the pollen or flour-pollen mixture from reaching the blooms.

Fruit set on tagged bunches. In the following discussion of fruit set we consider only the blooms first pollinated during April 10-28, the period when both temperatures and operating conditions were most favorable.

In the tall-palm block with the bloom duster fruit set averaged 2.5 fruit/inch when pollen was applied twice/week, and 1.8 fruit/inch when applied once/week (Fig. 4). Bunches were not tagged in the medium or short palm blocks because with the bloom duster method, fruit set is not affected by palm height.

In the tall-palm block with the palm duster fruit set averaged 2.1 fruit/inch when pollen was applied twice/week (Fig. 3), and 1.6 fruit/inch when applied once/week (Fig. 2). In the medium-palm block fruit set averaged 1.8 and 1.7 fruit/inch when pollen was applied twice/week and once/week, respectively. In the short-palm block fruit set averaged 2.2 fruit/inch, higher than in other blocks, and was equal for both application schedules. We feel that major reasons for these results in the short-palm plots are: 1) coverage of the blooms was more thorough with the hand-held pipe (Fig. 1) than with the long dusting pipe; and 2) the slower ground speed used in the once/week plots also improved coverage of the blooms, particularly during winds.

We also measured the fruit/inch for hand-pollinated bunches on selected palms in all blocks. These data (Fig. 5) show that the fruit/inch varied from nearly zero to 3.0. Most bunches had from 1.5 to 2.5 fruit/inch, although 19 to 43% had less than 1.0 fruit/inch. The scheduling of hand pollination was as good as could be expected.

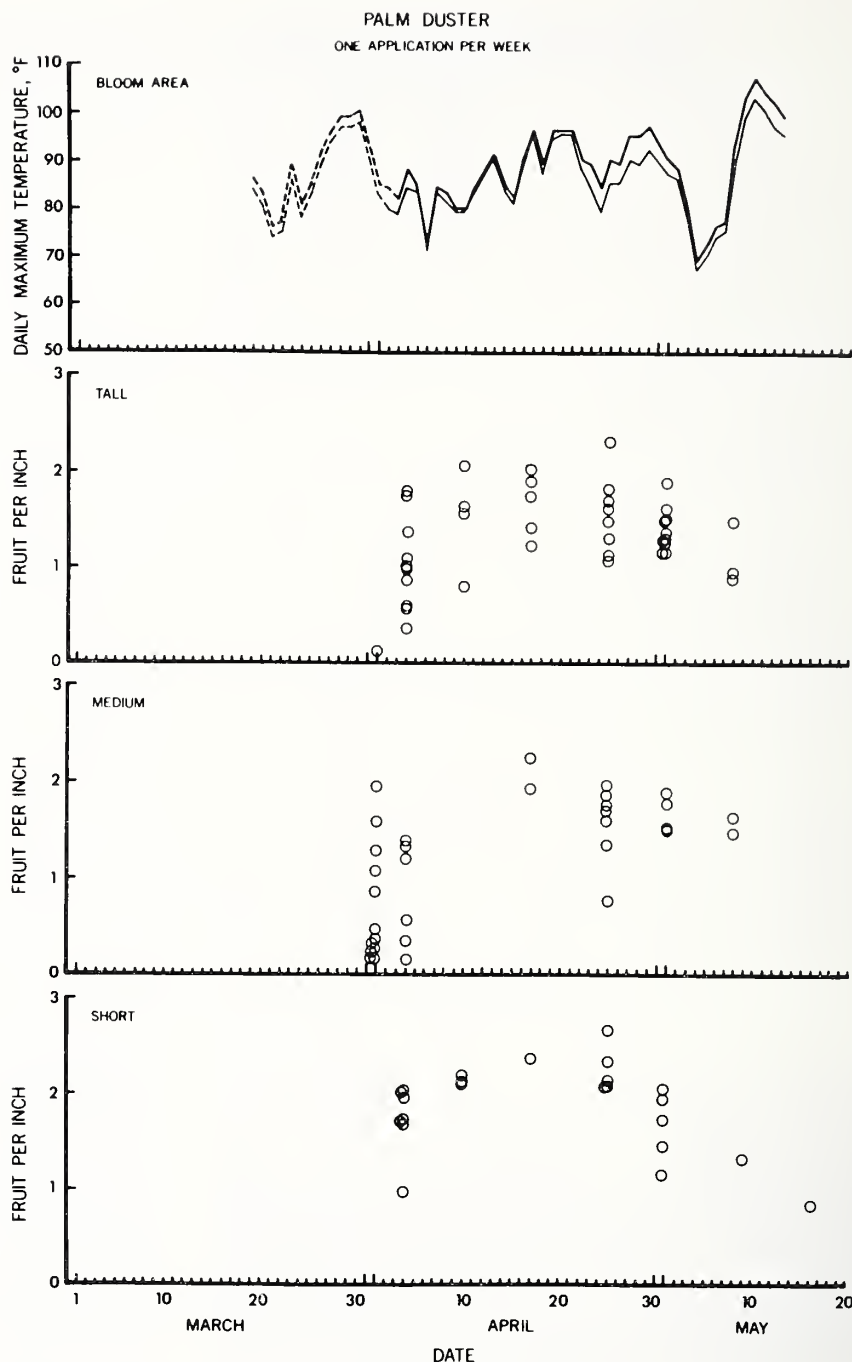


Fig. 2. Daily maximum temperature in the bloom area (temperatures in all plots were within the two lines shown), and number of fruit per inch of strand on tagged bunches of selected palms in the tall, medium, and short palm blocks. Data for each bunch are shown above the first date on which it was pollinated.

Average fruit set. The average bunch size and fruit size in each plot were used to calculate an average fruit/inch for the entire plot. In each block, one or more of the mechanical pollination treatments yielded more fruit/inch than hand pollination (Table 1).

The bloom duster, applying pollen twice/week, resulted in more fruit/inch than other methods in both the tall and medium palm blocks. One-half of each bloom-duster plot in the tall-palm block was thinned by removing the lower 2-3 inches of strand. We believe most of the difference in

fruit/inch between the thinned and unthinned plots occurred because the lower end of the strand has more than the average fruit/inch, so removing the lower end reduced the average fruit/inch. This also suggests that the average fruit/inch for each hand-pollinated plot would have been higher if the strands had not been end-cut.

The palm duster resulted in slightly less fruit/inch in the tall-palm block than did the bloom duster or hand pollination. In the medium-palm block the palm duster resulted in substantially less fruit/inch than other methods. A high percentage of the

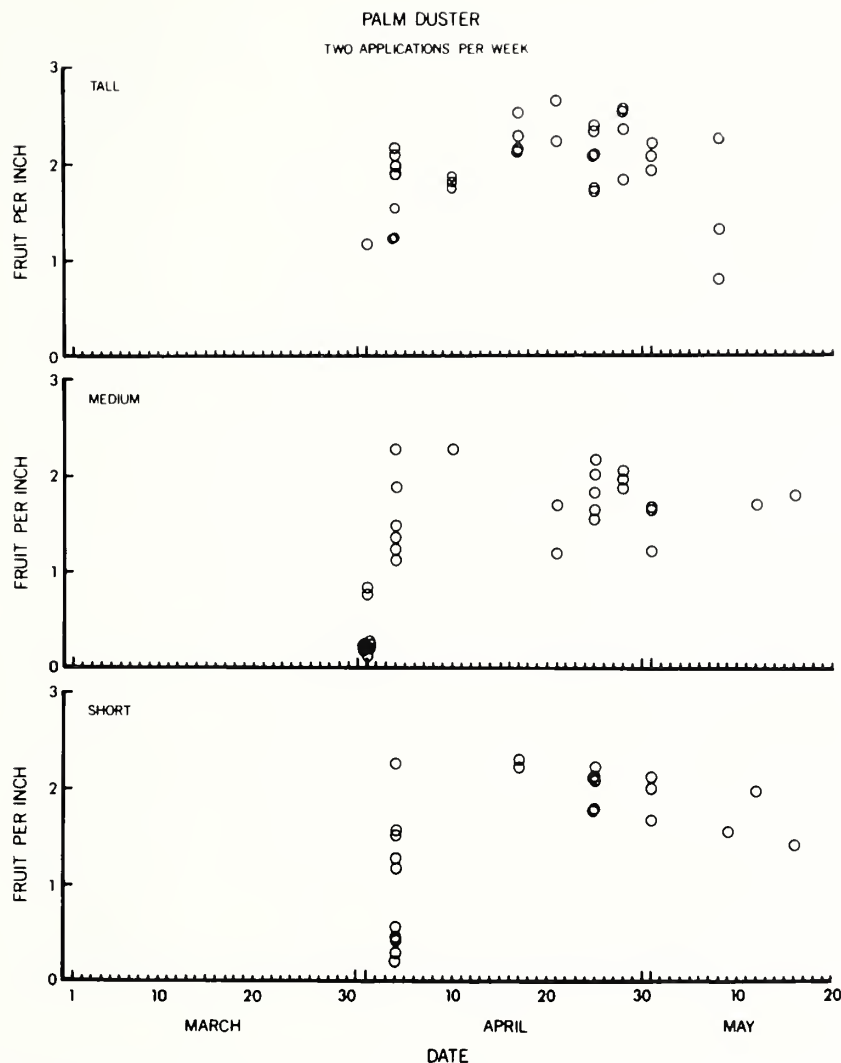


Fig. 3. Number of fruit per inch of strand on tagged bunches of selected palms in the tall, medium and short palm blocks. Data for each bunch are shown above the first date on which it was pollinated. Temperature data are given in Fig. 2.

blooms in these palm-duster plots were open early and winds were a frequent problem. In the short-palm block, the palm duster gave slightly better results than hand pollination.

Theoretical yield. The comparison of actual yield did not indicate a true difference between plots because the average number of bunches per palm and average bunch size in each plot were different. We calculated a theoretical yield for each plot, Table 2, by assuming: 1) the average number of bunches per palm was equal to that for hand pollination in that block; 2) the average bunch size was equal to that for all mechanical plots in each block; 3) the fruit size was the same as indicated on the receiving record; 4) the fruit/inch was as shown in Table 1.

Only the palm-duster plot 7 and the bloom-duster plot 4C, because of poor or late coverage on early blooms, had theoretical yields less than the hand-pollination

plot. Theoretical yield of the bloom-duster plots exceeded that of comparable palm-duster plots in the tall and medium-palm blocks.

Fruit quality and grower returns. The fruit size and pollinated yield of marketable, product, and cull grade fruit were not representative of what may be possible with mechanical pollination methods because all plots had a minimum of thinning. However, the grower returns (gross fruit value per palm as determined from the theoretical yield and actual fruit quality shown on the receiving records) were calculated for each plot (Table 2) to demonstrate the need for thinning. The fruit values assumed were 10.5 cent/lb. for marketable, 5 cent/lb for products and nothing for culls.

In each block the grower returns were highest, or next highest, for the hand-pollinated plot. Grower returns for mechanically pollinated plots were always highest if pollen was applied once/week rather

than twice/week. Also, returns were higher for the bloom-duster plots which were end-cut than for similar unthinned plots. These results emphasize that the number of fruit/bunch must be controlled to obtain high fruit quality and grower returns.

DISCUSSION

Fruit set in the bloom-duster plots which were pollinated twice/week was similar to the fruit set obtained in 1968. Applying pollen once/week instead of twice/week resulted in a loss of about 0.5 fruit/inch. However, because the theoretical yield and grower return compare closely with the actual yield and return for hand pollination, this loss appears acceptable. The equipment can be used on twice as much acreage with a once/week rather than twice/week schedule.

The palm-duster method did not result in a decrease in fruit set with an increase

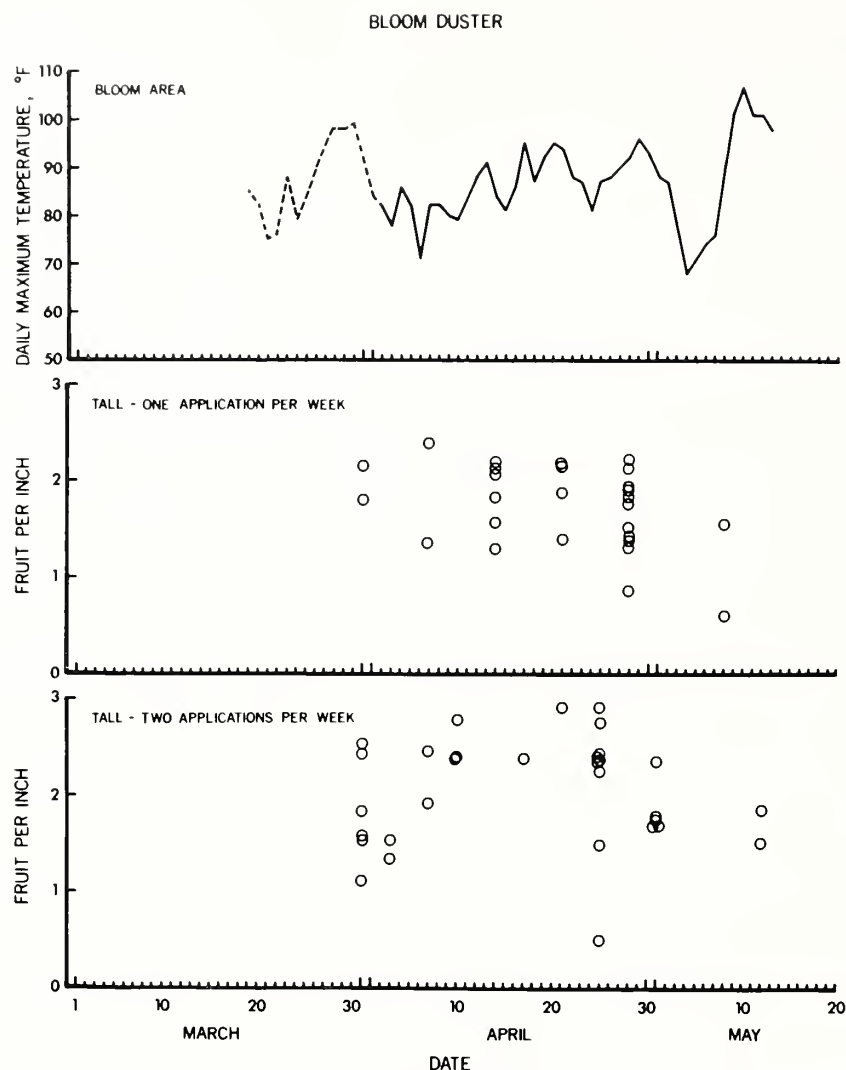


Fig. 4. Daily maximum temperature in the bloom area and number of fruit per inch of strand on tagged bunches of selected palms in the tall, medium and short palm blocks. Data for each bunch are shown above the first date on which it was pollinated.

in palm height, as in 1968. This year, the ability to position the duster nozzle close to most blooms minimized the effect of wind on the deposit of pollen on the bloom. However, if we had applied pollen to the tall palms in wind conditions similar to those in the short palms, the tall palms probably would have had poorer fruit set.

Pollen deposit tests. We conducted laboratory tests to determine the effect of: 1) type of nozzle used with the palm duster; 2) air velocity at the nozzle; 3) distance between the nozzle outlet and the bloom, on the number of pollen grains deposited on the stigmatic surface of the date flower. The date flowers were simulated with $\frac{1}{8}$ -inch diameter acrylic balls (spheres) mounted on $\frac{3}{32}$ -inch diameter by 18-inch long steel rods. The steel rods and nozzle were electrically grounded to eliminate uncontrolled static charges.

In replicated tests, 0.2 grams of pollen (the amount of pollen delivered by the duster each 1.76 sec) was blown through each nozzle and at the array of simulated flowers. Flowers which faced directly at or directly away from the pollen stream were examined for pollen deposit.

We concluded that pollen deposit on flowers which directly faced the pollen stream (Figs. 6-7) was about equal for the $\frac{3}{4}$ -inch nozzle at 450 mph (1968 experiments) and the 1-inch nozzle at 300 mph (1969 experiments). But, velocities less than these would result in less pollen deposit and make it more difficult to direct the pollen stream into the bloom during wind conditions. Pollen deposit on flowers which faced directly away from the pollen stream averaged less than 1 grain/mm², suggesting that pollen must be applied to both sides of the palm to result in uniform deposit on all exposed flowers.

Thinning requirements. We analyzed the data from all plots and found that the number of fruit per bunch had a major effect on fruit quality (Fig. 8). As the number of fruit per bunch increased, the yield which was lost in "marketable" went into "small" (part of culls), or, in other

Table 1. Average fruit set in each plot, La Quinta, 1969

Block	Plot	Pollination method & frequency	Average fruit set ¹	
			Fruit/Inch	Inches/Fruit
Tall palm	no.		fruit	inches
	4	Bloom 2/wk	2.16	0.464
	18	Hand	1.98	0.504
	3	Bloom 1/wk	1.97	0.508
	10	Palm 2/wk	1.92	0.520
	3E	Bloom 1/wk	1.86	0.537
	9	Palm 1/wk	1.84	0.543
Medium palm	4E	Bloom 2/wk	1.73	0.578
	2	Bloom 2/wk	2.40	0.416
	1	Bloom 1/wk	2.07	0.483
	17	Hand	1.73	0.579
	8	Palm 2/wk	—	—
Short palm, north	7	Palm 1/wk	1.18	0.849
	12	Palm 1/wk	1.68	0.597
	13	Palm 2/wk	1.55	0.644
Short palm, south	15	Hand	1.29	0.777
	11	Palm 1/wk	1.69	0.590
	14	Palm 2/wk	1.54	0.650
	16	Hand	1.49	0.669

¹ Fruit/inch is determined by dividing the average inches of fruiting strand per bunch into the average number of fruit per bunch. Inches/fruit (used in 1968 report) is the reciprocal of fruit/inch.

Table 2. Theoretical yield and grower return, La Quinta, 1969

Block	Plot	Pollination method & frequency	Bunch size	Theoretical yield ¹	Grower return ²
	no.		inches	lb/palm	\$/palm
Tall palm	3	Bloom 1/wk	807	412	25.26
	4	Bloom 2/wk	807	394	15.94
	10	Palm 2/wk	807	383	16.83
	9	Palm 1/wk	807	380	24.61
	3E	Bloom 1/wk	751	363	26.85
	4E	Bloom 2/wk	751	306	16.69
	18	Hand (16.3 bunches)	685	357	27.86
Medium palm	2	Bloom 2/wk	834	382	13.60
	1	Bloom 1/wk	834	348	16.22
	17	Hand (13.8 bunches)	709	261	18.02
	8	Palm 2/wk	834	—	—
	7	Palm 1/wk	834	235	18.55
Short palm, north	12	Palm 1/wk	773	233	13.14
	13	Palm 2/wk	773	216	9.80
	15	Hand (12.6 bunches)	693	175	12.29
Short palm, south	11	Palm 1/wk	765	169	5.28
	14	Palm 2/wk	765	147	4.15
	16	Hand (9.5 bunches)	704	143	7.66

¹ Determined by multiplying the Bunch Size shown by the number of bunches per palm shown for the hand-pollinated plot and the average number of fruit per inch, then dividing by the number of fruit per pound to obtain yield.

² Determined by assuming fruit values of 10.5, 5.0 and 0.0 cents/lb for marketable, product and cull, respectively.

words, returned the grower nothing — instead of 10:5 cent/lb. Also, the oldest (tall) palms were able to support more pollinated fruit per bunch than younger palms with the same percentage of yield in “marketable” grade. These results are based on the average number of pollinated fruit per bunch and average fruit quality for each plot. Thinning requirements could be more accurately estimated if the number and quality of fruit on each bunch were known, but quality data for each bunch are not available.

Using the data in Fig. 8, we estimated the average amount of thinning required to produce 70% “marketable” yield and a minimum of “small” yield. The number of fruit should not have exceeded 700-800 for the average bunch on short palms, 1,000 for medium palms and 1,200-1,300 for tall palms.

Under the above limits, bunches which were pollinated during April 10-28 should have been thinned by the following amounts: 30% for the bloom-duster plot in tall palms pollinated once/week, or 40% for twice/week; 20% for the palm-duster plot in tall palms pollinated once/week, or 35% for twice/week; 38% for the palm-duster plots in medium palms pollinated once or twice/week; 50% for the palm-duster plots in short palms pollinated once or twice/week. If temperatures had been between 70°F and 80°F for this period, thinning could not have exceeded ½ of the above amounts. No thinning would have been allowed if temperatures had been below 70°F. These percentages represent the fruit to be removed from each bunch. All of these values are only estimates, however, because no specific thinning tests were conducted in these experiments.

Thinning should be based on knowledge of the fruit set achieved, rather than on a fixed percentage for each bunch. At present, temperature records in addition to the beginning and ending dates of pollen application offer the best indication of probable fruit set.

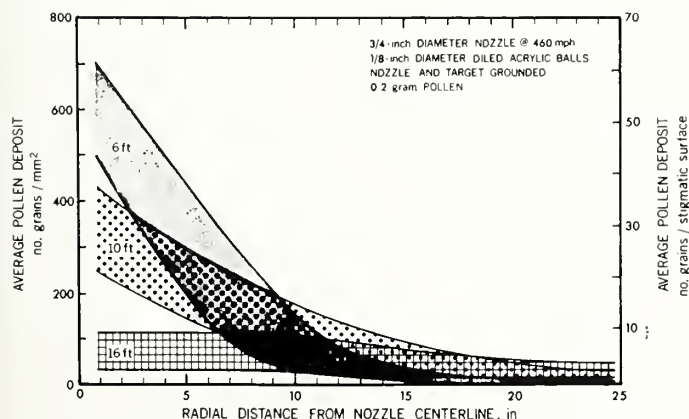


Fig. 6. Average number of pollen grains deposited on 1 mm² of a simulated date flower surface (left) and on an area equivalent to one stigmatic surface (right). Nozzle was 6, 10, or 16 ft from simulated flowers. Flowers directly faced the pollen stream.

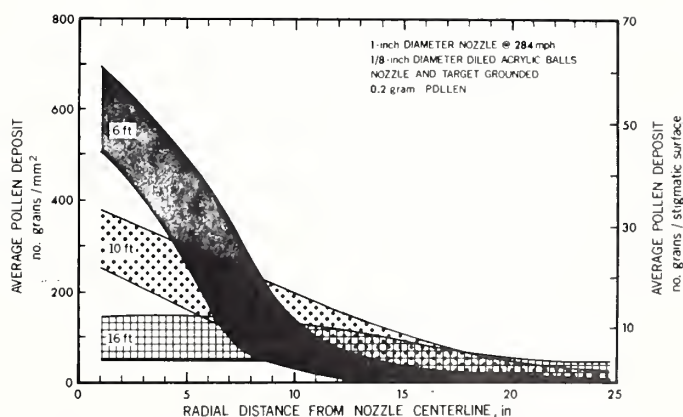


Fig. 7. Average number of pollen grains deposited on 1 mm² of a simulated date flower surface (left) and on an area equivalent to one stigmatic surface (right). Nozzle was 6, 10, or 16 ft from simulated flowers. Flowers directly faced the pollen stream.

HAND APPLICATION

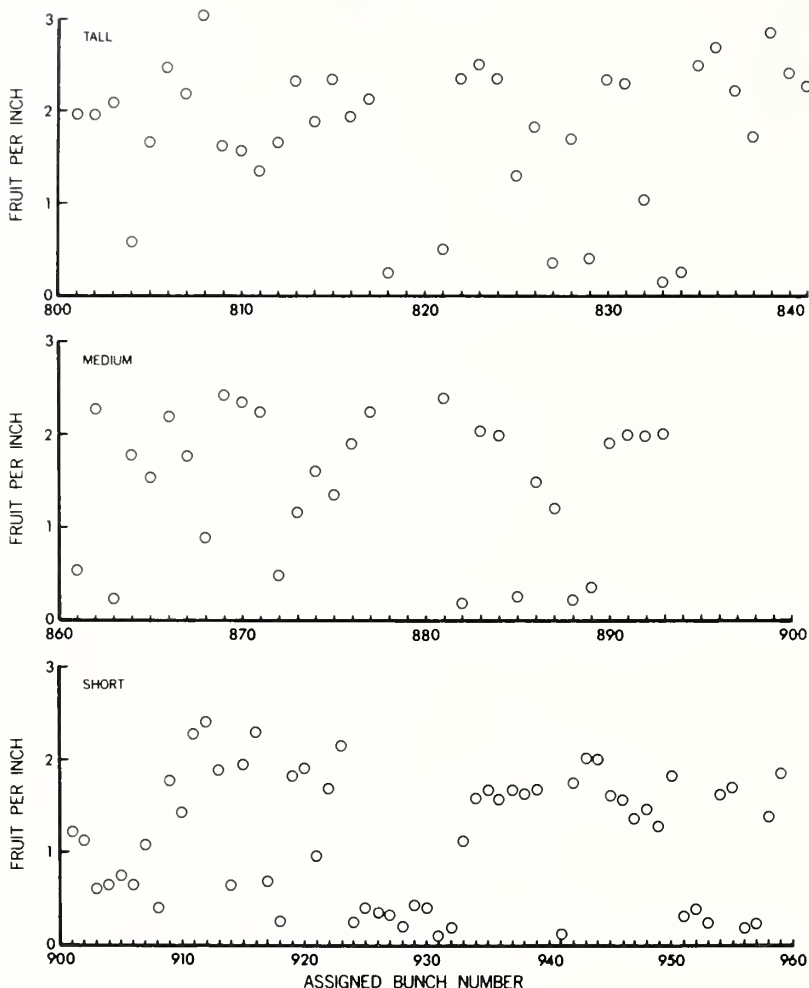


Fig. 5. Number of fruit per inch of strand for tagged bunches on selected hand-pollinated palms in the tall, medium and short palm blocks. Data for each bunch are shown above its assigned bunch number. Date of pollination was not recorded for each bunch.

CONCLUSIONS

1. Daily maximum temperature was favorable for good fruit set during most of the season although wind was a frequent problem.
2. Both mechanical pollination methods gave fruit set in most plots similar to that for hand pollination.
3. The bloom duster method of mechanical pollination gave better fruit set than the palm duster method.
4. During the period of 80°F or higher temperatures, all bunches which were mechanically pollinated should theoretically have been thinned by 20 to 50% in order to produce 70% "marketable" yield.
5. This year, mechanical application of pollen either once/week or twice/week theoretically would have given grower return equal to that of hand pollination.
6. Fruit set by the bloom duster method was similar to that obtained in 1968. Fruit set by the palm duster method was better than in 1968 and did not decrease with an increase in palm height.
7. Temperature in the bloom area of the palm should be recorded during the pollination season so that intelligent thinning decisions can be made.
8. Guidelines which relate temperature conditions and thinning requirements must be developed for grower use.
9. The exact effect of low temperature on the success of these mechanical pollination methods is not yet clear. Grower trials, on a limited scale, will accelerate the evaluation of these methods for commercial use.

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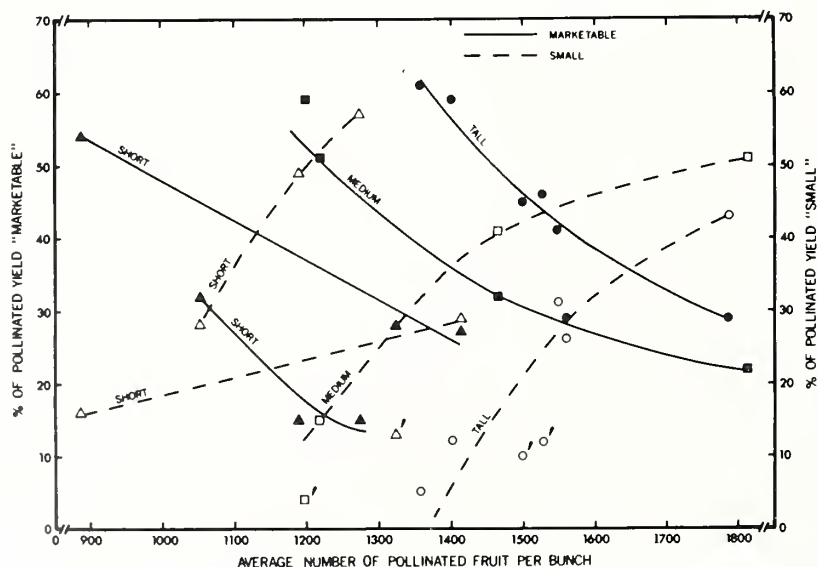


Fig. 8. Percent of pollinated yield in "marketable" and "small" quality grades versus the average number of pollinated fruit per bunch in the mechanically pollinated plots of tall, medium, and short palms. Data with a ' mark had unpollinated fruit present in the analyzed sample.

TISSUE CULTURE OF DATE SHOOTS AND SEEDLINGS

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Plant tissue culture techniques are widely utilized to investigate many horticultural and botanical problems in many crop plants. Culture of apical meristem to propagate virus-free orchid clones (3) and carnations (2), potatoes (4), cotton (1), and other tissues such as fruit for the purpose of studying such problems as temperature tolerance (7) and nutritional requirements (5) is now commonly accomplished. The potential value of tissue culture as a means to propagate date palm clones has stimulated some preliminary investigations both in Israel and California. The observations on some of these studies in California presented herewith represent a progress report.

The extensive investigations reported by Oppenheimer and Reuveni in Israel (6) on tissues and organs of date palms indicate negative results thus far. Attempts to induce root formation on lateral buds taken from the palm heart were unsuccessful. Other tissue explants maintained *in vitro* also failed to initiate root structures.

Among the major problems of conventional rooting of date offshoots on the mother palm is that of obtaining the offshoots in sufficient number for commercial propagation. This is particularly true in those clones which produce one or only a few offshoots per young palm. Wrapping the attached offshoot to induce rooting, separation and establishment of the offshoot in the nursery with certainty may, in some instances, require several years. The large size of offshoots weighing up to 40 pounds, cost of transportation, maintenance, inspection and handling must be considered in the general operation. The possible distribution of diseased or insect-infested offshoots is always a potential problem in such practices.

The use of offshoots cultured *in vitro* would provide the following advantages:

1. A large number of offshoots could be cultured from a given offshoot. Presumably, under proper conditions, each lateral bud from the "heart" could be induced to develop into an offshoot.
2. The resulting clonal material would be free of diseases and insects. The early stages of development would occur under sterile conditions which could produce virus-free clones even from a palm suspected to contain a virus.
3. Plants in early stages of such propagations could be cultivated in a restricted and small area for convenience of observation and maintenance. Offshoots propagated under these conditions could be transported by air at very low cost.

MATERIALS AND METHODS

The principle of tissue culture applied to the date palm in the present experiments

consisted of excising apical meristem tissue from the growing point of the young offshoot. Sometimes the entire lateral bud with or without a segment of leaf tissue was utilized. The apical bud portion of the offshoot was exposed by removing the leaf bases to provide access to the white succulent heart tissue. The heart was then surface sterilized in 10% Chlorox for 20 minutes or covered with alcohol and flamed. All subsequent steps then proceeded in a sterile transfer room. The outer portion of leaf bases was removed and the apical meristem approximately 5mm³ cut with a scalpel and placed on an agar nutrient medium in screw-top 6 dram vials. The vials were then incubated in temperature-and-light-controlled cabinets, usually at 25°C and in the dark or under approximately 600 f.c. fluorescent lamps. The nutrient medium generally used was White's (8) with modifications described later.

Results: Segments cultured from the pith of the apical bud showed some cellular proliferation but did not survive subtransfers. Proliferation from the base of young leaflets survived three subcultures in some cases, but eventually died. New leaves from apical buds appeared on those tissues maintained as continued transfers. One leaf taken in November 1966 developed a callus growth which was carried through seven transfers. This specimen showed root development in May 1969. Subcultures from this original piece now are in their 7th transfer. They have been sustained for three years on White's medium plus naphthalene acetic acid and coconut milk.

While most of the excised materials either failed to grow or showed no differentiation of root tissue, the single case above indicates the potential for tissue differentiation. Without doubt the technique can be modified in further investigations to produce more reliable results. Eventually control of tissue growth and differentiation may be achieved.

Various tissues from the heart of the palm offshoot were dissected and planted on agar nutrient medium. These tissues were classified as lateral buds from the axils of the embryonic leaves, leaf bases which included axillary buds, pith tissue from several locations within the apical portion of the offshoot and undifferentiated apical meristem tissue.

Several modifications of the basic medium were tried with addition of exogenous materials such as coconut milk, kinetin, indole acetic acid, naphthalene acetic acid, yeast and gibberellin.

Offshoots of Deglet Noor, Desert Nugget, Medjool and Honey date clones, each of which weighed from 10 to 20 pounds, were obtained from the U.S. Date and Citrus Station in Indio. The outer leaf bases were removed and the heart was cleaned by a brush. The heart was then soaked in 1:10 Chlorox solution for 25 minutes, drained, covered with alcohol and

flamed to surface sterilize the tissue. The various tissues were then dissected out under sterile conditions in the transfer room. Following transfer of tissue to appropriate media, the vials were maintained in standard temperature (25, 30, 35° C) and light-controlled (400-600 f.c.) incubators for observation.

Some preliminary trials were conducted at intervals during the past 10 years with various date palm tissues on different nutrient media both in liquid and agar. Casual observations showed some cellular proliferation on the cut surfaces and in some cases appearance of a root-like structure was detected. Many contaminations were originally experienced, possibly because of the complicated morphological structure of the heart, which can harbor spores and bacterial contaminants. The major response noticed in most of these early trials was the elongation of the embryonic leaves with occasional cellular proliferation on cut or exposed surfaces (Fig. 1 A, B, C.). Transfers of such materials to new media or a change of medium did not enhance the results. Eventually, experience has resulted in the development of the alcohol-soak-and-flame technique for tissue sterilization and the use of modified White's agar medium at pH 4-5 as the more profitable conditions under which to pursue the investigations.

Preliminary investigations on the culture of segments of germinating date seedlings indicate that some of the tissues are capable of establishment *in vitro*. Seeds were germinated under sterile conditions until the hypocotyl reached a length of 30 to 50 mm from which successive 10 mm sections were planted on White's medium with agar or in liquid form. The addition of indoleacetic acid and kinetin and a pH level of 4-5 were found most suitable for growth of these sections. The terminal 10 mm of the growing hypocotyl will develop both shoots and roots because the embryonic seedling is located in this portion (Fig. 1, E). One of these embryos has been successfully cultured free of its normally supporting seed endosperm and was established as an independent plant in a pot in the glasshouse. Sections taken at a greater distance than 1 cm from the apex sometimes formed roots but no shoots were developed under the conditions of the experiment. Root pieces developed from roots of the original embryonic tissue in turn developed secondary rootlets but no indications of shoot differentiation were detected on these root pieces.

In summary, it appears that development of propagation materials from apical meristem or lateral bud tissue of date palm offshoots may prove feasible with additional study. Preliminary observations indicate that proliferation and differentiation of date shoot tissue do occur *in vitro*. Induction and control of tissue differentiation have not yet been accomplished in the present series of investigations. Embryo culture of the date is quite feasible and was demonstrated.



Fig. 1. Date Tissue Culture.

- (A) Lateral bud and portion of leaf base from heart of date offshoot prepared for in-vitro culture.
- (B) Three lateral date buds from offshoot with attached segments of leaf bases on agar medium.
- (C) Apical buds from date offshoot on agar medium (same scale as in B).

- (D) Root primordia in date offshoot tissue callus which had been growing for several months.
- (E) Culture of date embryo, which has emerged from a 1 cm portion (still attached) of the cotyledonary sheath.
- (F) Date tissue callus showing differentiation of several possible shoot primordia and roots.
- (G) Root tip from date tissue callus in above Figure (F).

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MARKETING IN THE '70's -- THE LOOKING GLASS THROUGH THE OTHER END

WILLIAM W. WOOD, JR.¹

Traditional views of the producer of food and fiber have placed him in a position of significant stature — as if viewed through a telescope. As agriculture goes into the 1970's, that view has gradually been reversed so that the producer of food and fiber begins to decrease in significance.

The point of this analogy is to emphasize the perspective from which agriculture may be viewed in the future. The focal point will not be the producer but, rather, the ultimate marketing point — the consumer and his demand. Thus the agricultural sector of the economy begins to be viewed as the total effort to provide food and fiber for the nation irrespective of the identity of the producer.

Obviously, this has not occurred in a moment but, rather, is a continuing trend in the industrial development of our economy. There is essentially little new in the marketing of food and fiber but, rather, trends continue, perhaps with some intensification in a new direction. The question, then, is — What is the role of the agricultural producer in the marketing of food and fiber in the decade ahead? That role will be determined in a large measure by the ability of the producer to adapt himself to changes in the structure of marketing. Three aspects of marketing will be discussed briefly, not specifying what the producer's role will or should be but, rather, listing possible roles. These three facets will be: the organization of producers and the marketing channel; trends in the processing and merchandising of food and fiber; and the impact of substitute products.

Organization refers to both the physical structure and the strategies emerging in food and fiber marketing. It is a broadly defined term to note both formal and informal arrangements among actors in the production and marketing system. There are four general categories for organized marketing structures and/or strategies which have considerable impact.

The first category is direct marketing in which traditional marketing stages are bypassed or entirely absorbed by the producer-marketing firm. Typical is the mail-order business which has expanded substantially for a number of food products. To some extent, the producer who sells and ships directly to the ultimate retail marketer is likewise in this category.

The second type, similar to direct marketing, is vertical integration in which two or more stages in the marketing channel are combined under one management center. The broiler industry is a prime example of vertical integration including the supply of inputs such as feed, chicks and capital. The principal objective of vertical integration is to coordinate market services and product supply with demand.

A third type of organization, essentially a marketing strategy, is formula pricing whereby fairly long-term contracts for the supply of given product are negotiated but

without stipulating specific unit prices. Rather, these prices are tied through a specified formula to some other index of economic activity, traditionally some earlier wholesale market price. The trend now, since wholesale markets are less significant in price making, is to tie pricing to some sort of industrial index. In other words, the negotiations in conducting formula pricing are not with respect to unit price, per se, but with respect to other terms of sale and likewise to the formula by which ultimate price is determined.

The fourth type of organization could be termed group-negotiated pricing. In past years this has been given considerable impetus by the National Farmers Organization (NFO), which is attempting to negotiate price for food and fiber products through a group-action approach. While agricultural producers may not like the comparison, there is much in common between the concept of group-negotiated pricing in agriculture and labor unionism. The objective and the tactics tend to be quite similar. One should recall, however, that the concept of the marketing cooperative in agriculture is essentially one whose goal is group-negotiated pricing.

A second facet of marketing in the '70's is that of trends in processing and merchandising. Three general trends should be noted, none of them new but all important for the present and future producer. The first such trend is more and more regulated marketing. When the term "regulated" is used, not infrequently the reader will envision some sort of governmental imposition. In economic analysis, "regulated" marketing is not limited to governmental regulation but includes all attempts to coordinate production and consumption through the marketing channels. Thus, the large corporate firm that attempts to coordinate production with realized or projected demand is in effect attempting to regulate marketing. The principal point of regulated marketing is to achieve some degree of supply and demand equilibrium at a price level satisfactory to all of the parties involved in that particular product.

A second trend is readily observed — increased size of firms involved in production and marketing. The so-called conglomerate corporation is now involved in the production and marketing of food and fiber. For a number of reasons firms are increasing in size, not the least of which are access to additional capital, sufficient size to generate some market power, and the fact that as more and more specialized services are required by firms in production and marketing, there are economies of scale in acquiring those services. Included in this last item would be such things as computer programmers and operators, the hardware itself, as well as the more traditional use of attorneys, accountants, and other scientific specialists.

The third trend is more and more emphasis, particularly in the processing and merchandising fields, on non-price competition. Agriculture has traditionally tended to use price as its principal variable in competing for markets. To a large extent, this has separated the food and fiber industries from many other sectors of the

economy. The trends now are away from price competition toward other types in terms of sale, delivery procedures, financing, and many other facets of the total contract for sale. The least important variable then becomes the actual unit price. As discussed above, formula pricing tends to minimize the importance of unit price and to increase the importance of other variables in the contracting process.

In addition to organization and trends in processing and merchandising, a third facet of marketing in the years ahead is the so-called substitute products. One type is the product in which one food or fiber commodity is transformed and subsequently used to replace another such as the use of soybean protein to replace poultry or red-meat products and the use of vegetable oils to replace butterfat. The other type of substitute product is the complete synthetic in which some non-agricultural food or fiber product is used to replace the natural product such as the use of various types of synthetic fibers to replace cotton and wool and the use of pure chemicals to replace orange juice. In the next decade or so, it is entirely possible that not only will substitutes become more important, they may ultimately eliminate the traditional supply of food and fiber. Protein from petroleum by-products or various types of nutrients from algae or kelp or other sources could conceivably almost eliminate traditional food products. On the other hand, the attitude of the consumer toward the products available may dictate more directly the ultimate trend. The potential of this, however, is that it may be possible to combine soybean protein and some sugar form to make a quite adequate substitute for dates and date products.

An overview of marketing trends in the decade ahead emphasizes the fact that marketing is a specialized activity requiring a great deal of attention from a new perspective. The agricultural producer generally does not have this perspective, but if he anticipates being in existence as an agricultural producer ten years hence, he should look to the marketing organizations and strategies that seem appropriate for the commodity in question, acquire the professional expertise to develop markets, to expand markets, to take advantage of whatever consumer demand may exist and, above all, be will to abide with decisions dictated from the market place rather than from the production end in order to achieve some sort of acceptable equilibrium.

If, as at least one projection indicates, we will have as few as 750,000 producers of food and fiber products in the total United States by 1980, the question for each of today's producers to face is whether he wishes to be one of those 750,000. If the answer to that question is affirmative, then for his survival he needs to use his telescope to look at the market and not the production end of agriculture.

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SELLING DATES TO THE SUPERMARKET

JERRY FAHEY¹

My company is honored to be included in your program today. This area has been very good to us. It is a pleasure to do business with the high calibre of shippers that move this valley's produce. Our retail units have flourished under your patronage so we look forward to the opening of our new units here in Indio and over in Yucca Valley.

Your program chairman told me, "Remember you are talking to growers . . . tell it like it is . . . don't pull any punches." Well — I hope I'm not here to defend myself.

Commenting on the recent consumer boycotts, Betty Furness said she could understand why the housewives chose the retailer — he is their only contact with the market place. I suspect we are in the same spot with you — your contact with the market place.

I hope what I'm going to say doesn't strike you the same way it affected the editor of one grower publication. I had the dubious distinction of being described in this fashion: "We would like to believe this far-out idea was originated by some member of the lower echelon under the influence of a New Year's Eve hangover."

First, we are committed to the free enterprise system of American capitalism. One gentleman who seems to go along with us is George Meany, who said, "The American private enterprise system, despite some defects, has achieved far greater results for wage earners than any other social system in history."

Don't be surprised then when our buyers are concerned with obtaining goods at the lowest possible costs consistent with quality and service. We engage in buying and selling to make a profit. Unless we make money, we fail. On the other hand, we expect you to have pride in your product and to demand a price that will keep you in business. Any buyer will respect you for this. Out of this tug of war comes a business that has a long history of bringing food to the consuming public at minimum spreads between cost and retail.

Second, we are constantly seeking ways to reduce our cost of doing business by: eliminating out of stocks, improving ordering techniques, reducing inventory, improving transportation efficiencies, more effective advertising, better product presentation and creating case packs that reflect produce movement. We solicit your cooperation.

Third, we have some expenses, too. Items like bad checks, cash shortages, supplies, communications, laundry, rubbish, and maintenance all affect our selling price.

Our rent and depreciation bills exceeded six million dollars last year — good locations cost money. When clerks' wages are about \$4/hour, it is not surprising that our produce department payroll was nearly three million dollars in 1969.

We spend over four million dollars yearly in newspapers, radio, and television telling our customers about your product.

Fourth, another item that I'm sure you are aware of but that bears repeating is increased competition from product proliferation and advertising.

Our stands are really space for rent. Give us quality, service, and a price that will sell and the space is yours. But don't forget during two of your best selling months of the year, November and December, our date sales were less than 1% of our total produce volume. Dollar-wise we moved about as many yams or lemons as we did dates. To you, it is everything — a crop you have lived with and nurtured for twelve long months. To a buyer, it is just one of about 400 items on his list. If it is any consolation, dates were still in the top 10% of the dollar-getting items in our department during that period.

Now — some suggestions for getting the buyers' attention:

1. Use top flight sales representatives. We like to buy from people who like to sell . . . who know your product and who will be on hand to represent you if we have problems.

2. Watch your variety . . . we are familiar with Zahidi, Barhee, Khadrawy, Medjool, and Deglet Noor but we know there are many more. If you go in too many directions, you may confuse the customer by lack of product uniformity.

3. Help us keep up with consumer preference. I hear salesmen talk about "selling Vons" or "Cracking Vons". It's really not Vons that's being sold. Vons doesn't eat anything. It is our customers who are the buyers and prospective buyers.

I hope that helps to show that you and I have the same objectives — to do a better job of finding out what the customer wants and what she will buy. We welcome any ideas that will help us to sell more goods. We welcome market information that will help us in our merchandising. We welcome information on economic trends or developments which may affect sales of your product.

4. Use top quality advertising material. Avoid material that could be offensive to your customers.

5. We sympathize with your desire to automate as much as possible, but please make as your goal a package that shows the product rather than the packaging.

In a fresh fruit and vegetable department, impulse buying is 70% of the game. We want dates to stop her. After that is done, you can increase the utility of the product by brand name, size, price and recipes.

6. Make every effort to keep your product flowing smoothly into the market place. We don't like wide fluctuations in prices any more than you do. We think price stability builds customer confidence.

7. Last but not most important . . . establish industry-wide quality standards that you can be proud of. We think customers are more likely to think in terms of "good value" than of "red hot bargains". Put pride in your product and then fight for every penny of the customer's dollar you can get.

¹ Produce manager, Vons Grocery Company, Los Angeles, California.

ADVERTISING AND COMMODITY TRENDS

FLETCHER OAKES¹

Advertising and the Grower. I shall try to show how advertising helps the grower. My talk has three parts:

1. A brief discussion of advertising; what it really is; and what's good and bad about it.
2. A simplified comparison of food marketing, yesterday and today.
3. Some statistics and trends that I hope you will find interesting.

A well-advertised product is worth more money than its unadvertised counterparts. It returns more profit to producer, distributor and retailer; and the customer is better satisfied.

What is advertising? It is anything you do to tell people the product is available; it has highly desirable attributes; use of it will make them happy, the benefits it provides far outweigh the small price they are asked to pay.

Advertising has been around for a long time, at least 10,000 years that we know of; the only advances are in techniques and media. It has degrees of quality and value; good, mediocre, bad and awful. Worst of all, it can be wasteful, even when it is good. Bad advertising does not do much harm; it just doesn't do anything, so that's a waste. Because the effect of bad advertising is innocuous, it continues. Much the same can be said for mediocre advertising.

On the other hand, the favorable effects of good advertising are enormous. In some cases, it can be said that advertising was the major factor in a dramatic business success. But remember, even good advertising can be wasteful. That happens when the amount of money spent is not enough to make good advertising conspicuous. So, my point in all this is that value in advertising for the grower is present only when the advertising is good and the money spent to circulate it is enough to get it seen, heard or read by all the potential buyers.

Food marketing. Dramatic changes have occurred in marketing during the past 20 years. I remember fruit and vegetable peddlers in wagons. Some carried a variety, whatever was available. Others just peddled one or 2 items as they came in season; all of them called out their wares and how good they were — fresh, ripe, delicious. The rest of the produce available was sold in corner fruit stores. Grocers just carried potatoes, turnips, onions, and other staples. The customers' choice was limited. A product coming in season was exciting. The main point is they all sold the products directly, personally and aggressively. With little or no refrigeration they had to.

The two most important differences today are: 1) Available variety — frozen, dehydrated, canned, freeze dried, and fresh, with a difference; fresh is available almost all year round. This means all products compete with each other, continuously. People don't have to fill up in season.

The old excitement of the first strawberries, asparagus, and peaches, is gone. The consumer is jaded; the retailer feels no enthusiasm. 2) The sellers are different. There are no peddlers on the street "advertising." No corner fruit stands "hawking" in modern shopping centers. Instead, we have super markets. The manager has to worry about 8,000 to 10,000 items. The store employees, including produce clerks, are shelf stockers. The home office advertises prices, not products. It doesn't care about individual products; there are too many. All it cares about is traffic because traffic generates volume. The office has to name products to sell prices, "hot specials", and you might think this is advertising your product. But remember, it is really only saying one thing about your product: it is cheap. Some manufacturers even pay for this, which is called cooperative advertising.

Today's retailer doesn't sell — he simply exposes. A computer tells him what to expose, when and where, in how many inches or feet of space. I hope that these observations stand comparison with your own. Further, I hope the implications are obvious. If you want your product to be exposed, it must sell in volume sufficient to appease the computer. You are really not competing with other brands of your product, but with almost every other food product. For a product to get exposed and to find a place in the consumer shopping basket, someone has to sell the consumer; good advertising does that.

Where is the payoff in this? What we are really talking about here is called "value added by advertising". Is there such a thing? An example exists in any cocktail lounge or bar. If you order a scotch, gin or bourbon, the tab will be from \$.65 to \$.75. If you order Ballantines, Tanqueray or Harper's, the tab will be \$.85 to \$1.00, about \$.15 extra for the "eal brands". This is \$.40 per quart. The average expenditure for advertising for the leading brands of liquor is about \$.25 per quart, but the selling price is \$.405 per quart more for advertised brands.

An exceptional case, perhaps. You are well aware of the more modest premium of major brands over private labels in most other products. Yet people pay the extra, for the same quality in most cases. It's worth something to them. Call it psychic reward; and, remember, it is the consumer who pays. I call this value added by advertising.

Let us consider the trends during the past 10 years in consumption of rice, potatoes and dried beans in comparison with a base period of 1957-1959 taken to equal 100. The average value of domestic consumption of rice, potatoes and beans was, respectively, \$170 million, \$1.3 billion and \$353 million. The money spent on advertising was for rice \$10 million, for potatoes \$3.7 million, and for beans practically nil. The 10-year trend in consumption showed an increase of 44% for rice, an increase of 9% for potatoes, and a decrease of 19% for beans.

The use trend of margarine, butter and eggs in the past 10 years is another illustration of the value of advertising. In my opinion, butter is a delectable, natural product. I like it; everybody likes it. It

enhances other foods. It is good for you in reasonable quantities. Oleomargarine, a substitute, has cholesterol, like other fats, and just as many calories, in spite of slyly stated claims. There is no way to sell it except to claim that it is as good as butter. It costs half as much as butter. The average person uses 11 pounds per year, so they save maybe \$15.00 per family, per year, by using it.

The margarine makers take in \$610,000,000 per year. They spend more than \$27,000,000 or 4%, selling it. The butter makers take in \$1 billion a year and spend only about \$1 million selling it, one-tenth of one percent. In comparison with the base period ('57-'59 = 100) the 10 year trend in consumption of margarine showed a rise of 22%, and that of butter a decline of 46%. The use trend of eggs shows a different situation.

Eggs have no real "counterpart competitor". No one has invented a substitute. Almost nothing is spent on advertising. There are no real brands, and the prices are cheap. I sold eggs for more than present prices 20 years ago. The industry has made fantastic, almost unbelievable, efficiencies to keep the price down and hold its market; but its market is still dribbling away. The use trend was down 10% in the past 10 years. The savings in cost made by producers has been passed on to the consumer. This is socially altruistic, and the consumers are showing their appreciation by using less every year. How much longer can producers cut prices to stay in business? Someone is going to start "selling" eggs one of these days, at realistic prices.

The use trends of all citrus, fresh citrus, bananas, and all fresh fruit may be closer to the primary interest of the date producer. The 10-year-use trend of all citrus and bananas showed little change from the base period ('57-'59); that of fresh citrus was down 21% and that of all fresh fruit was down 22%. You see that fresh citrus follows the fresh fruit pattern, but when frozen and canned are combined with it, consumption is maintained at a level rate. The banana trend is interesting; it is holding its own. It is sold almost exclusively as a fresh product, in the same places, under the same circumstances. Very curious. You may be able to attach some significance to the advertising figures. \$3 million spent on bananas with a \$600 million sales value; \$10 million spent on all citrus — \$1.2 billion total — \$860 million fresh. I couldn't separate "fresh only" advertising.

But, here is a factor in the citrus picture — \$25 million spent on orange juice synthetics (Awake, Tang, and Start, and so-called canned orange juice drinks). There's a point here. In many ways, what you must spend depends on what's being spent against you. Now, about \$5 million spent on advertising is on all other fresh fruit. The value of this fruit is over \$3.5 billion. Consider the advertising expenditure to sales ratio for bananas, one-half of one percent, and they are just holding their own. Remember the average of advertising to sales for food products is 4%. If only one-half of one percent were spent on all other fresh fruit, it would be a competitive war chest budget of \$17.5 million, instead of \$5 million. With this we might just

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possibly stay even, like bananas, and all citrus; or maybe even grow a little.

In my opinion, the industry is wasting its \$5 million. But I would not dare say: "stop" because I have no way of knowing how much faster the loss in consumption would be if it did.

A comparison of use trends of avocados, raisins and dates for the past 10 years with the base period ('57-'59) is of vital interest to the date grower. Raisins are similar to dates. Raisin producers spend about \$2 million advertising a \$130 million crop, more than 2% of the value of domestic consumption. In the past 10 years raisins showed an increase of 4% in consumption, avocados an increase of 25%, and the use trend of dates was down 50%. The avocado picture is significant. The avocado is a fresh fruit that many people never heard of 10 years ago. The avocado producers spend 5.5% of crop income for advertising. There has been a 25% increase in usage, a 100% increase in returns to the grower and they get \$9 million more for the crop.

I haven't said anything about the dates.

You can tell me more than I know. I do know this: That a 50% usage loss in the face of all the things we have considered cannot be explained away by the usual cliches about changing tastes, customs and conditions. All the products discussed have pertinent implications for date growers. Raisins have significant relationships, but the most important are the things we can see in the avocado case.

There are too many correlations between avocados and dates to be ignored. Some are: relatively small crops; basically limited production, long term period required to bring in increased production; limited growing area; limited number of growers and handlers to organize for cooperative actions; specialty products, not a basic commodity subject to emotional price resistance; product quality superiority over foreign competition. Plus: more consumer acceptance compared to avocados 10 years ago and even today; non-perishable-long shelf life; many more consumer uses, plus "products" for manufacturer use; bonafide consumer benefits — they are a confection and a treat; a real existing market of

regular users, at least double the one you are reaching. So why do you sell them so cheaply and so reluctantly?

We are trying to find out if advertising can help the grower. This is a hard task. There are hundreds of other variables that can affect the price and enhance or negate the effects of advertising. Weather, crop size, behavior of buyers and sellers, are only a few. However, I hope you will agree to a few points I tried to illustrate: the marketing climate is different and still changing; the retailer is no longer doing the selling; good advertising is the only known substitute to reach the consumer; there is real evidence that some products have increased or maintained their share of space in the consumer's shopping basket; some products have lost their shares, and one critical difference between them seems to be advertising; advertising can "add value" to a product. A well-advertised product is worth more money than its unadvertised counterpart. It will return more profit to grower, distributor and retailer. The customer will be better satisfied and will pay gladly; so that the advertising pays for itself.

MEMBERSHIP ROLL 1970-1971*

SUSTAINING MEMBERS

Berryman, Harley (Berryman Farms) P.O. Box 882, Bard
Brown, T. R., Rt. 2, Box 81 Thermal
Cavanagh, H. L., 76-353 Hwy. 111 Palm Desert
Date Administrative Committee, Box 764 Indio
Furr, J. R., U.S. Date & Citrus Station,
44-455 Clinton St. Indio
Iraqi Dates Organization Baghdad, Iraq
Remy, Henri, Apartado Postal 22,
Saltillo, Coahuila, Mexico
Shields Date Gardens, 80-225 Hwy. 111 Indio
Swingle, Leonhardt, 44-566 Swingle Ave. Indio
Weinert, A. H., Smoke Tree Ranch Palm Springs
Yowell, Hillman, 43-900 Oasis Ave. Indio

REGULAR MEMBERS

Allen, E. or Sarah M., P.O. Box 1416 Indio
American Date Gardens (Paul Green),
Rt. 1, Box 211 Thermal
Azhderian, Leo, 6864 W. Clinton Fresno
Baker, Donald F. & Rowena,
319 E. Randolph St. Glendale
Blackburn, R. W. & Sons, Rte. 2, Box 266 Thermal
Buxton, Steve, Rte. 1, Box 214 Thermal
Carpenter, John, U.S. Date & Citrus Station,
44-455 Clinton St. Indio
Carreon, Dr. R. J. Jr., Drawer CC Indio
Cashin, E. A., 1305 Shoreline Dr. Wayzata, Minn.
Clark, William J., 37-165 Palm View Rd., Cathedral City
C.M.B.G. Ranch (J. C. Pixton), P.O. Drawer YY Indio
Coachella Citrus Co. (Joe Keeva),
16055 Ventura Blvd. Encino
Coachella Ranches (D. A. Stevning),
51-064 Monroe St. Indio
Coachella Valley Fruit Co.,
(D. H. Mitchell), Box 833 Indio
Codekas Bros., P.O. Drawer E Indio
College of the Desert,
43-500 Monterey Ave. Palm Desert
Cramer, Bill & Betty, 8122 E. Second Ave., Mesa, Ariz.
D Bar B Ranch (J. A. Michelson),
5890 Cozzens St. San Diego
Diemer & Oberlin, R.R. 1 Pontiac, Ill.
Dixon, W. L. Co. (Pete Dondero),
81-931 Victoria St. Indio
Dorado Enterprises (c/o Kaufman, Enzer & Co.),
13107 Ventura Blvd. Studio City
Dunlap, D. D., Box 322 Thermal
El Mina Date Garden (Victor deFontenay),
P.O. Box 170 Alice Springs, Australia
Embleton, Tom W., 209 Horticulture Bldg.,
Univ. of Calif. Riverside
Ensley, Harold E., P.O. Drawer 1787 Indio
Fair Acres Ranch (David H. Mitchell),
P.O. Box 833 Indio
Fairfield Farms, Box 564 La Quinta
Fruit & Food Tech., Research Institute,
Chief, Private Bag Stellenbosch, South Africa
Gibbs, Gordon (c/o D. A. Stevning)
51-064 Monroe St. Indio
Hilgeman, Robert, Univ. of Ariz.,
Citrus Branch Station Tempe, Ariz.
Hopland, A. N., 49-773 Monroe Indio
Howie, Robert M., Riverside County Agric.
Commissioner, 4080 Lemon St. Riverside
Hughes, Larry, 11421 Chenault St. Los Angeles
Jamison, Homer B., Rt. 1, Box 101 Coachella
Johnston, Oswald L., P.O. Box FFF Indio
Keck, Albert P. Company, P.O. Drawer FF Indio
Kerwin Exprmntl., c/o Cal Date Field Ser.,
P.O. Drawer HHH Indio
Lafin, Ben, Sr., Box 757 Thermal
Lafin, Ben, Jr., Box 757 Thermal
Lauderbach, Leon W., 1451 Bryan Ave. Tustin
Leach, George H., Rte. 2, Box 115 Thermal
Leslie Ranch Nurseries, 81-360 Avenue 50 Indio
Lesser, Dr. Joseph H., c/o 140 Luring Dr., Palm Springs

Lindgren, David L., Entomology Dept.,
Univ. of California Riverside
Livingston, Walter, 1310 Wilshire Blvd. Los Angeles
Lluvia De Oro Ranch (I. H. Buxton),
4056 Williams Ave. La Verne
Longley Ranch, 120 E. 4th St.,
Bnk. Amrc. Trs. Dept. Long Beach
Loma Verde Ranch (c/o D. Stevning),
51-064 Monroe St. Indio
Loud, A. R., P.O. Box 2039 Pomona
Marx, Donald, P.O. Box 1478 Palm Springs
McLain, V. C., Estate, 1420 Seventh St. Wasco
McLeod, Rose L., 622 Main St. Lewiston, Idaho
Morris, Arden S. & H. R., 4200 Berford Way, Pasadena
Muhs, Arthur B., Box Y Palm Springs
N & N Ranch (c/o W. Newsom),
18151 Williams Highway Grants Pass, Ore.
Nelsen, Helen, 644 S. Rimpau Blvd. Los Angeles
Nicoll, R. C. (Valerie Jean Date Shop),
66021 Hwy. 86 Thermal
Nixon, Roy W., 81-229 Palmyra Ave. Indio
Oasis View Ranch, 75-475 Desert Park Dr., Palm Desert
Odum, Bruce W., Box 787 Indio
Odum, Floyd B., Box FFF Indio
Olesen, Kay, P.O. Box 205 Palm Desert
Olivieri, Pat (c/o H & O Ranch),
970 Sierra Way Palm Springs
Oro Del Sol Ranch (c/o D. Stevning),
51-064 Monroe Indio
Osman, Awad M. A., Hudeiba Res. Sta. Sudan
Patterson, K. K., 81-370 Date Palm Ave. Indio
Philbrick, Dr. R. E., 6695 Magnolia Ave. Riverside
Pierson, Rollins, 7845 Torreyson Dr. Los Angeles
Puls, J. H. Ranch, 72-789 Bel Air Rd. Palm Desert
Rancho Ramona, Inc., 81-855 Hwy. 111,
Room 2-J Indio
Rapkin, Joseph, 735 W. Water St. Milwaukee, Wisc.
Reuther, Walter, Dept. of Hort. Science,
Univ. of California Riverside
Richardson, H. B., Hort. Science Bldg.,
Univ. of California Davis
Riverside County's Nat'l. Date Festival,
P.O. Box 1387 Indio
Robinson, Donald, U.S. Dept. of Agriculture,
45-235 Towne Indio
Royal Medjool Date Ranch, Box 551 Yuma, Ariz.
Rummonds, Bros. (c/o Harboe Mng.),
P.O. Drawer 1787 Indio
Rutherford, Paul, Rte. 1, Box 73 Coachella
Schmid, Thomas, Rte. 1, Box 35 Coachella
Schmid, Walter, 7931 Lampson Ave. Garden Grove
Shearer, S. K., M. D. Et al,
511 Toyopa Dr. Pacific Palisades
Siemen, Evelyn M., Box 44 Palm Desert
Skar Ship Corp., 21 West St. New York, N.Y.
Smart, Jackson W., 81-165 Francis St. Indio
Smigel, George E. Corp.,
2017 Granville Ave. Los Angeles
Snell, Foster D., Inc., Hanover Road, Florham Park, N.J.
Snow, Dr. Rodney H., 301 - 20th St. Santa Monica
Soloro Ranch (W. Murphy), P.O. Box 632 San Jose
Stoek, Edward C. & Pat, Rte. 1, Box 720 Thermal
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